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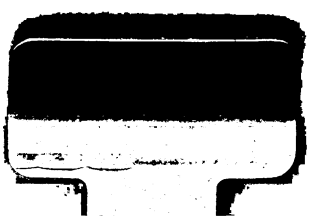

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Circular 31 February, 1921

A Study of the Food Habits of the Ring-Necked Pheasant in Colorado

By W. L. Burnett

Feeding Habits and Food of the Ring-Necked Pheasant

By Asa C. Maxson

Office of the State Entomologist
COLORADO AGRICULTURAL COLLEGE
Fort Collins, Colorado

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A Study of the Food Habits of the Ring-Necked Pheasant in Colorado

By W. L. Burnett

ACKNOWLEDGMENT

The writer wishes to offer the following acknowledgments: To Director C. P. Gillette, for insect determinations and advice; to Mr. R. G. Parvin, State Game Commissioner, for many courtesies; to Mr. A. C. Maxson, for notes on the food habits of the Ring-necked Pheasant at Longmont; to Mr. W. F. Kendrick, for valuable information concerning the early history of the pheasants in Colorado; to the members of the Departments of Botany and Entomology, Colorado Experiment Station, for assistance in identifying weed seeds and insects; to the farmers of the northern part of the state for courtesies extended in the way of shooting privileges on their farms. They have all shown much interest in the work, and we extend to them our appreciation.

The ring-necked pheasant (*Phasianus torquatus Gmel*) is a native of southern Siberia, Korea and northeastern China. Several species of pheasants have been introduced into different sections of the United States, but this one has adapted itself to our conditions better than any of the others.

According to data furnished by Mr. W. F. Kendrick, the first attempt to introduce pheasants into Colorado, was about 1875, when an Englishman brought in a trio, two hens and a cock, from England, and liberated them on his ranch on Turkey Creek, Jefferson County. One hen and the cock were shot the same day by a local grouse hunter.

In 1889, Senator Henry M. Teller gave Mr. Edward O. Wolcott, a number of pheasants he had secured from the East. Mr. Wolcott liberated these on his ranch known as Wolhurst, near Littleton, Arapahoe County.

In 1894, Mr. W. F. Kendrick started to import pheasants in large numbers, which were liberated in the vicinity of Denver, and

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in other sections south and west, but for various reasons, these pheasants failed to multiply and became exterminated except in the Denver, Littleton and Golden sections. They were introduced into northern Colorado about 1908.

By the courtesy of Mr. Roland G. Parvin, Game Commissioner of Colorado, the writer was granted a permit to take fifty pheasants during the year 1920, for the study of thier foodhabits, as the following letter will indicate:

STATE OF COLORADO
Game and Fish Department
Capitol Bldg.
Denver

February 14, 1920.

ROLAND G. PARVIN,
Commissioner.
MR. W. L. BURNETT,
c/o Colorado Agricultural College,
Fort Collins, Colorado.

Dear Sir:

In the interest of the Colorado Agricultural College in its experimental work for the benefit of the farmers of the state, and of this department jointly, I hereby authorize you to take fifty pheasants during the year 1920 for the study of their food habits.

Yours very truly,

R. G. PARVIN,
Game and Fish Commissioner.

The writer always has been, and is yet, strongly in favor of bird protection. Yet we must take issue with writers on economic ornithology who study the food habits of a certain bird in some locality, and find it beneficial or injurious, as the case may be, and publish statements that they apply to the whole country. In our opinion a bird may be beneficial or injurious in one locality, and the opposite in another. We believe this may be true even in different localities in the same state.

The robin is reported by all investigators as one of our beneficial birds, which is probably true. Yet, in our state, it does considerable damage to the cherry crop, especially on the Westrn Slope where sweet cherries are grown. But, if it were not for our commercialism, we would think nothing of that, but would gladly raise cherries, grain or other foods for our own use and the birds! So long as the dollar rules the world, we must take the commercial point of view.

It is a question if, in some sections, the good done by certain birds in the destruction of injurious insects or weed seeds, offsets the harm done to fruit and other crops.

The writer entered into the study of the food habits of this pheasant with an unbiased mind and we are here giving the results,

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but no conclusions as to its economic status. We have tried to treat the subject wholly on its merits, and not from the farmer's or sportsman's standpoint, as we are neither, but a bird student of some thirty years.

We shall have to admit, however, that we are prejudiced against any and all imported or foreign birds, as our native birds have been placed here by nature to fit each particular environmental condition and any foreign bird is out of harmony with nature.

We believe it is a fallacy of our present game laws to protect the pheasant and allow an open season on the fast disappearing sage grouse, the noblest gallinaceous game bird of the West, a bird that harmonizes with its surroundings, and a sight of which always brings to us delight and a breath of the sage-brush plains.

We admit that from the sportsman's standpoint there are no comparisons between the pheasant and the sage grouse, as the pheasant is quick on wing or foot, and when flushed, does not hesitate in its flight, but as it rises from cover, it goes at once into high, with the throttle wide open. As a rule it does not fly far, but soon alights on the run, as only a pheasant can. In the air it presents a fair straightaway target.

DISTRIBUTION

The ring-necked pheasant is found in the following counties in Colorado: Denver, Jefferson, Adams, Arapahoe, Larimer, Weld, Morgan, Logan, Douglas, Elbert, El Paso, Boulder, Delta and Otero.

It is abundant in Adams, Arapahoe, Jefferson, Boulder, Weld and Larimer Counties and occurs sparingly in the others.

It is gradually invading the foothill regions of the state. Rockwell and Wetmore state that it occurs on top of Lookout Mountain, Jefferson County, at an elevation of 7500 feet (A List of Birds from the Vicinity of Golden, Colorado, Rockwell and Wetmore, Auk, July, 1914). It has been reported to the writer from Log Cabin, Larimer County, at an elevation of 8,000 feet. Mr. Parvin, State Game Commissioner, reports it from Estes Park, and the writer saw a male specimen in September, 1914, near Dawson, Platte Canyon, at an altitude of 6,397 feet.

CROP and STOMACH CONTENTS OF INDIVIDUAL BIRDS

No. 1.—Male, March 13, 1920, from edge of fall wheat field, 3½ miles northeast of Fort Collins, 8:30 a. m.

CROP CONTENTS: 3 grains of sprouted wheat.

GIZZARD CONTENTS: 1 seed of lady-finger (*Polygonum persicaria*), some finely ground vegetable matter, leg of dried grasshopper.

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No. 2.—Male, March 15, 1920, taken along railroad 6 miles southeast of Fort Collins, 2:00 p. m.

CROP CONTENTS: Nothing.

GIZZARD CONTENTS: Finely ground vegetable matter only.

No. 3.—Female, April 9, 1920, edge of alfalfa field east of Fort Collins, 2:30 p. m.

CROP CONTENTS: 272 grains of wheat, 3 alfalfa leaves, 1 beetle (*Aphodius sp.*); 1 beetle larva (*Carabid*).

GIZZARD CONTENTS: Finely ground wheat, 11 seeds of ragweed (*Ambrosia trifida*); 8 seeds of white mustard (*Sinapis alba*).

No. 4.—Female, April 9, 1920, edge of alfalfa field east of Fort Collins, 2:30 p. m.

CROP CONTENTS: Nothing.

GIZZARD CONTENTS: Finely ground vegetable matter, 7 seeds of ragweed.

No. 5.—Female, April 9, 1920, edge of alfalfa field east of Fort Collins, 3:00 p. m.

CROP CONTENTS: 1 beetle (*Aphodius sp.*); 221 grains of sprouted wheat.

GIZZARD CONTENTS: Finely ground wheat, 1 seed of black bindweed (*Polygonum convolvulus*), 11 seeds of ragweed, 4 seeds of white mustard.

No. 6.—Female, April 27, 1920, edge of spring-wheat field, 6 miles north of Fort Collins, 3:30 p. m.

CROP CONTENTS: 2 grains of germinated wheat, 21 leaves of alfalfa, 2 grains of barley, 187 grains of oats, 56 grains of wild oats, 1 larva of carabid beetle, 1 dipterous pupa.

GIZZARD CONTENTS: Finely ground grain, a number of oat hulls.

No. 7.—Male, April 30, 1920, edge of spring-wheat field east of Fort Collins, 3:30 p. m.

CROP CONTENTS: 1 seed of wild oats.

GIZZARD CONTENTS: 1 seed of wild oats, a number of wheat sprouts, 6 seeds of Indian bread-root (*Psoralea*).

No. 8.—Male, April 30, 1920, edge of spring-wheat field east of Fort Collins, 3:30 p. m.

CROP CONTENTS: 35 grains of germinated wheat.

GIZZARD CONTENTS: 33 seeds of mustard (*Brassica sp*); 23 seeds of Vetch (*Vicia*); 2 seeds of sunflower (*Helianthus*).

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No. 9.—Female, May 18, 1920, near alfalfa field 3 miles northeast of Fort Collins, 6:30 p. m.

CROP CONTENTS: A number of alfalfa leaves, 1 dandelion bud, 6 ants, 7 beetles (*Eleodes extricata, 1; Blapitinus sp., 2; Aphodius inquinatus, 4;* legs of dried grasshopper.

GIZZARD CONTENTS: 3 ants, 6 beetles (*Scarabids, 3; Chrysomela conjuncta, 1; Baris sp., 1; Thecesternus numeralis, 1*).

No. 10.—Male, May 18, 1920, in wheat field northeast of Fort Collins, 5:30 p. m .

CROP CONTENTS: Alfalfa leaves.

GIZZARD CONTENTS: Alfalfa leaves, 1 grain of germinated wheat.

No. 11.—Male, May 19, 1920, in wheat field 10 miles southwest of Fort Collins, 4:30 p. m.

CROP CONTENTS: 48 grains of oats, 1 beetle (*Melanactes sp.*)

GIZZARD CONTENTS: 7 grains of germinated wheat, 53 fragments of wheat.

No. 12.—Male, May 19, 1920, in wheat field 6 miles southwest of Fort Collins.

CROP CONTENTS: 67 grains of germinated wheat.

GIZZARD CONTENTS: 1 seed of mustard, 71 grains of germinated wheat.

No. 13.—Female, May 31, 1920, along roadside 6 miles northeast of Fort Collins, 6:30 p. m.

CROP CONTENTS: 4 seeds of wild oats, 274 grains of sprouted barley, 70 beetles (*Chrysomela exclamationis, 7; Chrysomela conjunta, 4; Monoxia puncticollis, 26; Graphorhinus vadosus, 2;* small *Curculionids, 10; Aphodius inquinatus, 12; Phylobrotica decorata, 1; Blapstinus sp., 6;* small *Elaterid, 1; Harpalus, 1; Harpalus, 1*); Alfalfa webworm (*Loxostege commixtalis*) 1.

GIZZARD CONTENTS: 43 whole grains and a number of fragments of barley.

No. 14.—Male, May 31, 1920, along roadside 6 miles northeast of Fort Collins, 6:45 p. m.

CROP CONTENTS: 12 beetles (*Chrysomela exclamationis, 6; Leptinotarsa decemlineata, 5; Chrysomela conjuncta, 1*).

GIZZARD CONTENTS: 2 beetles (*Silpha ramosa, 1,* and *Chrysomela exclamationis, 1*); grain sprouts and alfalfa leaves.

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No. 15.—Male, June 4, 1920, edge of wheat field 2 miles west of Loveland, 4:30 p. m.

CROP CONTENTS: 27 grains of germinated corn.

GIZZARD CONTENTS: 1 seed of Indian bread-root, 1 whole grain of corn and mass of ground corn.

No. 16.—Male, June 4, 1920, roadside 6 miles northeast of Fort Collins, 7:30 p. m.

CROP CONTENTS: 14 beetles (*Leptinotarsa decemlineata, 7;* sun flower beetle, *Chrysomela exclamationis, 15,* and *Diplotaxis haydeni, 2;* seeds of wild oats and 28 ants.

GIZZARD CONTENTS: 6 beetles (*Diplotaxis haydeni*), 6 seeds of Indian bread-root, 1 grain of wheat, 2 cherry pits, 1 pinto bean.

No. 17.—Male, June 18, 1920, in alfalfa field 10 miles east of Fort Collins, 7:00 p. m.

CROP CONTENTS: 193 alfalfa web-worms (*Loxostege commixtalis*).

GIZZARD CONTENTS: 123 mustard seeds (*Brassica*); 29 alfalfa web-worms (*Loxostege commixtalis*); mass of partly digested worms, some leaves.

No. 18.—Male, June 29, 1920, in alfalfa field 8 miles northeast of Fort Collins, 5:30 p. m.

CROP CONTENTS: 259 alfalfa web-worms, 1 ant, 1 spider.

GIZZARD CONTENTS: 76 partially digested alfalfa web-worms.

No. 19.—Female, July 10, 1920, in wheat field east of Loveland, 3:00 p. m.

CROP CONTENTS: 67 grains of unripened wheat, 2 beetles (*Eusattus difficilis, 1; Trimytis pruinosa, 1*).

GIZZARD CONTENTS: 9 beetles (*Eusattus difficilis, 8; Trimytis pruinosa, 1;* 54 grains of unripened wheat, 97 seeds of mustard.

No. 20.—Male, July 12, 1920, edge of wheat field 8 miles east of Fort Collins, 5:00 p. m.

CROP CONTENTS: 231 grains of unripened wheat, 1 Lepidoterous pupa.

GIZZARD CONTENTS: 67 seeds of mustard, a mass of partially digested unripened wheat.

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No. 21.—Male, July 15, 1920, in alfalfa field four miles north of Fort Collins, 7:30 p. m.

CROP CONTENTS: 79 grains of unripened barley, alfalfa leaves, 15 beetles (*Chrysomela exclamationis, 2; Campylenchia curvata, 1; Systena bitaeniata, 9; Calocoris superbus, 1; Collops vittatus, 2);* 2 ants, 2 dandelion buds, 1 Pyralid larva.

GIZZARD CONTENTS: Some alfalfa leaves and a mass of partially digested vegetable matter.

No. 22.—Female, Aug. 17, 1920, in barley field three miles northwest of Fort Collins, 4:00 p. m.

CROP CONTENTS: 2 dandelion buds, 167 grains of barley, 1 sunflower beetle (*Chrysomela exclamationis*).

GIZZARD CONTENTS: 37 whole grains of barley and a number of fragments of same.

No. 23.—Male, Aug. 26, 1920, in alfalfa field five miles northeast of Fort Collins, 4:30 p. m.

CROP CONTENTS: 1 grasshopper, 14 grains of unripened oats, 1 cutworm.

GIZZARD CONTENTS: 2 cutworms, 2 carabid larvae.

No. 24.—Male, Aug. 26, 1920, in field of shocked wheat five miles northeast of Fort Collins, 4:15 p. m.

CROP CONTENTS: 45 grains of wheat, 19 berries of nightshade (*Solanum triflorum*).

GIZZARD CONTENTS: 38 whole grains of wheat and a number of fragments of same.

No. 25.—Male, Aug. 26, 1920, in field of shocked barley five miles northeast of Fort Collins, 4:45 p. m.

CROP CONTENTS: 9 grains of wheat, 43 grains of barley.

GIZZARD CONTENTS: 27 seeds of black bindweed, 21 grains of barley, 50 grains of wheat

No 26.—Young female, two-thirds grown, Aug. 31, 1920, 3 miles northeast of Fort Collins, 4:30 p. m.

CROP CONTENTS: 1 alfalfa leaf, 3 grains of wheat.

GIZZARD CONTENTS: 3 grains of wheat, 7 seeds of black bindweed, 149 seeds of green foxtail (*Setaria viridis*).

No. 27.—Young half-grown female, Sept. 8, 1920, in corn field near Waverly, 3:00 p. m.

CROP CONTENTS: 1 seed of black bindweed.

GIZZARD CONTENTS: 228 seeds of black bindweed.

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No. 28.—Young, two-thirds grown, Sept. 8, 1920, in alfalfa field near Waverly, 3:00 p. m.

CROP CONTENTS: Remains of one grasshopper, 109 seeds of wild sunflower.

GIZZARD CONTENTS: 3 grains of wheat, 41 seeds of wild sunflower.

No. 29.—Young, half-grown, Sept. 8, 1920, in alfalfa field near Waverly, 3:00 p. m.

CROP CONTENTS: 3 grasshoppers, 4 grains of barley, 214 seeds of wild sunflower.

GIZZARD CONTENTS: 6 grains of barley, 76 seeds of wild sunflower.

No. 30.—Young female, two-thirds grown, Sept. 16, 1920, between field of shocked wheat and corn field near Waverly, 4:00 p. m.

CROP CONTENTS: 416 grains of wheat, 30 seeds of wild sunflower.

GIZZARD CONTENTS: 75 grains of wheat, 22 seeds of black bindweed, 61 seeds of wild sunflower.

No. 31.—Young female, two-thirds grown, Sept. 27, 1920, in wheat stubble near Windsor, 4:00 p. m.

CROP CONTENTS: 174 grains of wheat, 4 beet web-worms (*Loxostege sticticalis*).

GIZZARD CONTENTS: 58 grains of wheat, remains of 4 beet web-worms.

No. 32.—Young male, two-thirds grown, Sept. 27, 1920, in wheat stubble near Windsor, 4:00 p. m.

CROP CONTENTS: 1 beet web-worm, 396 grains of wheat.

GIZZARD CONTENTS: 47 grains of whole wheat and a number of fragments of same.

The beet web-worm in the crop was alive and able to crawl when crop was opened 16 hours after pheasant was killed.

No. 33.—Immature male, Oct. 12, 1920, in wheat stubble 3½ miles northeast of Fort Collins, 3:00 p. m.

CROP CONTENTS: 31 grains of wheat, 1 black nightshade berry.

GIZZARD CONTENTS: 12 grains of wheat, 8 seeds of black bindweed, 1 seed of wild sunflower, 109 seeds of green foxtail, 129 seeds of black nightshade, remains of one grasshopper.

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No. 34.—Male, October 21, 1920, in corn field near Ault, 3:00 p. m.

CROP CONTENTS: 9 black nightshade berries, 32 grains of corn.

GIZZARD CONTENTS: A number of fragments of corn.

No. 35.—Immature male, November 2, 1920, in beet field three miles north of Fort Collins, 4:00 p. m.

CROP CONTENTS: 278 grains of wheat.

GIZZARD CONTENTS: 16 whole grains of wheat and a number of fragments of same.

No. 36.—Immature female, November 2, 1920, in beet field, three miles north of Fort Collins, 4:10 p. m.

CROP CONTENTS: 221 grains of wheat, 29 grains of oats, 2 seeds of wild sunflower.

GIZZARD CONTENTS: 20 whole grains of wheat, a number of fragments of same, 8 seeds of wild sunflower.

No. 37.—Female, November 8, 1920, in wheat stubble near Windsor, 4:00 p. m.

CROP CONTENTS: A number of alfalfa leaves, 141 grains of wheat, 3 grains of wild oats.

GIZZARD CONTENTS: Fragments of wheat.

No. 38.—Male, November 10, 1920, in alfalfa field near Loveland, 5:00 p. m.

CROP CONTENTS: 495 grains of wheat, 1 chrysalis of alfalfa web-worm, 1 aphid (*Lachnus dentata*), 1 beetle (*Paederus littorarius*).

GIZZARD CONTENTS: 113 grains of wheat, 3 seeds of wild sunflower (*Helianthus sp.*, 1 seed of ragweed, 1 seed of Indian bread-root, 206 seeds of smartweed *(Polygonum sp.)*, a mass of digested wheat.

No. 39.—Male, November 13, 1920, in wheat stubble near Fort Collins, 2:30 p. m.

CROP CONTENTS: 112 grains of wheat.

GIZZARD CONTENTS: A number of fragments of wheat.

No. 40.—Male, November 15, 1920, in alfalfa field near Windsor, 2:30 p. m .

CROP CONTENTS: Nothing.

GIZZARD CONTENTS: 3 seeds of wild sunflower, 16 seeds of black nightshade, mass of partly digested vegetable matter.

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No. 41.—Male, November 15, 1920, in wheat stubble near Windsor, 4:00 p. m.

CROP CONTENTS: 142 grains of wheat.

GIZZARD CONTENTS: 13 whole grains of wheat, and a number of fragments of same.

No. 42.—Young male, November 17, 1920, on ditch bank, College Farm, 5:00 p. m.

CROP CONTENTS: 24 grains of corn, 47 grains of oats, 8 nightshade berries, 1 seed of wild sunflower.

GIZZARD CONTENTS: 9 grains of corn, 31 seeds of black bindweed.

No. 43.—Male, November 23, 1920, in plowed field, College Farm, 4:45 p. m.

CROP CONTENTS: 195 grains of corn, 17 grains of oats, 46 seeds of black bindweed.

GIZZARD CONTENTS: 14 whole grains of corn, a number of fragments of same, 19 seeds of black bindweed.

No. 44.—Male, Deecmber 1, 1920, in plowed field near Loveland, 3:30 p. m.

CROP CONTENTS: 68 grains of corn.

GIZZARD CONTENTS: 3 grains of whole corn, a number of fragments of same.

No. 45.—Female, December 2, 1920, edge of corn field near Wellington, 4:30 p. m.

CROP CONTENTS: 42 grains of corn, 388 grains of wheat.

GIZZARD CONTENTS: 7 grains of corn, a number of fragments of same, 15 grains of wheat and a number of fragments of same.

No. 46.—Male, December 2, 1920, in corn field near Wellington, 4:15 p. m.

CROP CONTENTS: 53 grains of corn.

GIZZARD CONTENTS: 6 grains of corn, a number of fragments of same, 6 seeds of black bindweed.

No. 47.—Male, December 15, 1920, in alfalfa field west of Fort Collins, 5:00 p. m.

CROP CONTENTS: 51 grains of wheat, 4 seeds of wild sunflower.

GIZZARD CONTENTS: 3 whole grains of corn, 8 whole grains of wheat, a number of fragments of corn and wheat, 5 seeds of black bindweed, 34 seeds of green foxtail.

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No. 48.—Male, December 30, 1920, in plowed field north of Waverly, 4:30 p. m.

CROP CONTENTS: 1027 grains of wheat.

GIZZARD CONTENTS: 85 whole grains of wheat, and a number of fragments of same.

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Summary

ON FOOD HABITS

From our investigations, we find that the ring-necked pheasant is an omnivorous feeder, with grain its favorite food, showing a decided preference for wheat; and that it is by no means the extremely insectivorous bird it has been supposed to be.

When we began our investigations on the food habits of the pheasant, it was our opinion that the young birds might feed almost exclusively on insects, and but little on grains or weed seeds. Our investigation does not bear out this opinion. Eight young birds taken in August, September and October, had eaten fourteen insects, 1228 kernels of grain, and 1235 seeds of weeds. Of the eight birds, five had taken insects, six weed seeds and seven grain.

The following is a list showing the different grains, weed seeds and insects taken by the forty-eight birds examined.

CLASSIFICATION OF FOOD MATERIALS

GRAIN

Corn	Wheat
Oats	Barley

WEEDS

Lady-finger (*Polygonum persicaria*)
Ragweed (*Ambrosia trifida*)
White Mustard *(Brassica sp.)*
Bindweed (*Polygonum convolvulus*)
Wild oats (*Avena fatua*)
Indian Bread-root (*Psoralea sp.*)
Black Mustard (*Brassica sp.*)
Wild Sunflower (*Helianthus sp.*)
Black Nightshade (*Solanum nigrum*)
Nightshade (*Solanum triflorum*)
Green Foxtail (*Setaria viridis*)
Smartweed (*Polygonum sp.*)
Dandelion buds (*Leontodon*)
Nightshade berries (*Solanum sp.*)

INJURIOUS INSECTS

ORTHOPTERA

Grasshoppers—*7*

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COLEOPTERA (Beetles)

Monoxia puncticollis—26
Phyllobrotica decorata—1
Leptinotarsa decemlineata—12
Systena bitaeniata—9

LEPIDOPTERA

Alfalfa web-worm *(Loxostege commixtalis)*—558
Beet web-worm *(Loxostege sticticalis)*—11
Cutworms—3

HOMOPTERA

Lachnus dentatus—1

BENEFICIAL INSECTS

COLEOPTERA (Beetles)

Harpalus sp.—1
Silpha ramosa—1

NEUTRAL INSECTS

COLEOPTERA (Beetles)

Paederus littorarius—8
Elateridae—1
Collops vittatus—2
Scarabaeidae—5
Aphodius inquinatus—17
Diplotaxis haydeni—8
Chrysomela conjuncta—6
Chrysomela exclamationis—32
Trimytis pruinosa—2
Eusattus difficilis—9
Eleodes extricata—1
Blapstinus sp.—8
Thecesternus numeralis—1
Graphorhinus vadosus—2
Curculionidae—10
Baris sp.—1

DIPTERA

Puparium—1

LEPIDOPTERA

Lepidopterous pupa *(Pyralid)*—1

HYMENOPTERA

Ants—40

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ARACHNIDA

Spider—1

HETEROPTERA

Campylenchia curvata—1
Calocoris superbus—1

MISCELLANEOUS VEGETABLE MATTER

Alfalfa leaves
Cherry pits—2
Vetch seed
Pinto beans—1

MISCELLANEOUS NOTES

Grains Eaten:

Twenty-eight of the forty-eight birds taken at different seasons of the year had eaten wheat to the extent of 5517 grains, or an average of 197.1 grains per bird.

Six birds had eaten 634 grains of barley, or an average of 105.4 grains per bird.

Eight birds ate 546 grains of corn, or an average of 65.6 grains per bird.

Six birds ate 342 grains of oats, or an average of 57 grains per bird.

Total kernels of all grains found in the crops and gizzards of the forty-eight birds killed during the season, 7039, or an average of 146.6 kernels of grain for all birds taken, which is probably not more than one-half the daily ration. This does not take into consideration fragments, and partially digested kernels that could not be counted.

According to our observations, pheasants usually feed twice a day, in the early morning and evening, and the above paragraph gives an average grain portion of one meal for one day for forty-eight birds.

In early spring and fall they feed mostly on waste grains, but at planting time they feed on germinated corn, wheat and barley, and in the growing season on the grain in the milk.

Grain was found in stomachs of birds taken in every month from March to January. As no birds were taken in January or February, we have no records of their food habits for these two months, but no doubt grain is eaten every month of the year.

Weed Seeds Eaten

In the stomachs of twenty-eight of the birds examined, we found a total of 2127 seeds of noxious weeds divided as follows:

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lady-finger, 1; ragweed, 30; white mustard, 165; bindweed, 482; wild oats, 69; Indian bread-root, 12; black mustard, 170; wild sunflower, 555; black nightshade, 145; green foxtail, 292; smartweed, 206, a total of 2127.

From the above we may conclude that sunflowers furnish the favorite weed seed, as indicated by the number of seeds eaten, and also the large number of birds that feed on the seeds of this weed.

As this plant is very abundant along the roadsides and ditch banks, also in some of the fields, it is surprising that more of the seeds were not taken We failed to find a single bird that had been feeding on the cultivated species, although several were taken near fields of the cultivated variety

The next largest item in the list of weed seeds is black bindweed, which was taken by eight birds. This is a common and troublesome weed of the grain and cultivated fields. A bird that would feed extensively on the seeds of this weed would be a blessing.

One bird had taken one seed of lady-finger, four birds thirty seeds of ragweed, eight birds three hundred thirty-five seeds of mustard, five birds sixty-nine seeds of wild oats, four birds twelve seeds of Indian bread-root, one bird two hundred six seeds of smartweed, two birds one hundred forty-five seeds of black nightshade and three birds two hundred ninety-two seeds of green foxtail.

Insects Eaten

The forty-eight birds ate, during the season, a total of seven hundred eighty-eight insects divided as follows: injurious 628, beneficial 2, and neutral 158.

The largest item in the list is the alfalfa web-worm, amounting to 558, all taken by three birds; one bird eating 335, another 222, and another 1, and one bird had taken one chrysalis of this worm.

Alfalfa web-worms were very abundant this past season, swarming in the fields by millions. This is also true of the beet web-worm, of which eleven were eaten by three birds.

All pheasants examined during the season failed to live up to their reputation as grasshopper feeders, none had taken the eggs, and only seven grasshoppers were taken, three of which were old, dry insects that had been picked up dead. In this section of the state, grasshoppers were not abundant enough to do any noticeable damage to farm crops, but were common in all the fields.

Cutworms were very common this season, but only one bird had taken them and to the extent of three worms. Apparently the pheasants scratch little, if at all, for their food.

Beetles were taken to the extent of one hundred twenty-three, of which ninety-eight were neutral, twenty-three injurious and two beneficial.

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In 1916, Mr. A. C. Maxson, of The Great Western Sugar Company, Longmont, Colorado, was granted a special permit to take twelve male pheasants, for food habit studies. This data has never been published and Mr. Maxson kindly gave us permission to include the results of his investigation here. This we are very glad to do, as it is a valuable addiiton to our records. Mr. Maxson's paper follows:

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Feeding Habits and Food of the Ring-Necked Pheasant[1]

By ASA C. MAXSON, *Longmont, Colorado*

During the summer, fall and early winter of 1916, the writer studied, in a small way, the feeding habits of the ring-necked pheasant in connection with the taking of 12 males birds under special permit No. 25, issued by the Colorado Game and Fish Commission.

During the nesting season, the ring-necks, especially the females, feed quite locally. The same birds have been observed day after day feeding in the same field. As will be seen from the examination of the stomachs of the birds taken, the food eaten depends quite largely upon the local supply. This local feeding and the fact that a great variety of vegetable food is eaten, point toward a possibility of great local damage especially in truck-garden districts and near favorite nesting places.

The corn pulling habit of this bird results in quite heavy damage where this crop is grown and the birds are numerous. Sugar beets in all stages of development and the roots set out for seed production are damaged to quite an extent, specially near nesting grounds.

It has been noticed that the greatest damage has occurred near alfalfa fields and waste ground which is covered with a heavy growth of weeds. Such places afford concealment during the day and furnished protected nesting places.

After the young leave the nest, feeding is not quite as local as during the nesting period. It is probable that more insects are eaten by the young growing birds than by the adults, however there is no direct evidence that this is the case.

During the fall the birds congregate about waste land near water and in places where the weeds and sweet clover of the previous season afford hiding places and protection during the night. Feeding at this season seldom results in loss to agriculture only when the birds are numerous in fields where unhusked corn is standing.

Feeding generally takes place during the early hours of the morning and during the last two or three hours before dark. In the middle of the day the birds are much less in evidence. During the nesting season the males are more bold and may be seen strutting about giving their harsh call accompanied by the rapid flapping of the wings at any hour of the day.

[1]*Phasianus torquatus* Gmel.

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Stomach Contents

In giving the results of the examination of the stomach contents of the birds taken, no attempt has been made to express the different items in percentages.

Bird No. 1

Killed 6 P. M., May 29th, 1916, consorting with females near a cattle feeding pen.

Crop Contents

1 kernel of barley
2 kernel of corn
1 snap-beetle *(Elateridae)*
Several leaves of lambsquarter and buds and leaves of butter-cup *(Ranunculus sp.)*

Gizzard Contents

1 *Lachnosterna* larva (white grub)
1 grasshopper
1 tiger-beetle *(Cicindela sp.)*
Many ground-beetles *(Carabidae)*

The vegetable substance consisted of partially digested wheat, barley and corn, probably waste from the feed lots.

Four injurious insects were destroyed. To off-set this many beneficial ground-beetles and one tiger-beetle were eaten. Since the number of beneficial insects eaten out-numbered the injurious forms, the recent feeding of this bird must be considered as harmful rather than beneficial.

Bird No. 2

Killed 5:30 P. M., May 31st, 1916, feeding where straw stack had stood and about 10 rods from a seed-beet field.

Crop Contents

14 kerneles of wheat
7 pieces of beet pulp nearly equalling the wheat in total bulk.

Gizzard Contents

23 kernels of wheat
3 seeds of a legume

The animal matter in the gizzard consisted of the remains of numerous ground-beetles, one leaf-beetle.

Sugar beet pulp doubling the bulk of all other items combined completed the contents.

In the destruction of ground-beetles and the eating of sugar beets, this bird did some damage. The only injurious insect eaten

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was the leaf-beetle. As this was not of importance as a crop pest agriculturally, no real good resulted from the recent feeding of this individual.

Bird No. 3

Killed June 2nd, 1916, at side of road near plowed field recently sown to barley which was not yet up. Time, 11:30 A. M.

CROP CONTENTS

The crop of this bird contained no trace of food.

GIZZARD CONTENTS

Partly digested barley, 1 kernel of wheat and one ragweed seed together with several nightshade leaves composed the bill of fare of this bird so far as vegetable matter was concerned.

The remains of several ground-beetles and 1 potato beetles were the only evidence of insects in the crop.

It is quite evident that this bird breakfasted in the recently sown barley field mentioned above. The potato beetle was no doubt taken from the nightshade, the leaves of which were found in the gizzard. The taking of this injurious beetle was off-set by the destruction of ground-beetles and the taking of barley. This bird's feeding can not be considered as beneficial to agriculture.

Bird No. 4

Killed at border of alfalfa, south of experimental field at Longmont. 6 P. M., June 2nd.

CROP CONTENTS

4 alfalfa leaves

GIZZARD CONTENTS

2 kernels of germinated corn
1 ground-beetle
Portion of 1 earthworm.

The balance of the food found in this bird's gizzard consisted of partly digested vegetable matter. There was evidence of corn and barley. Several small roots which appear to be from the germinated corn were also present.

The germinated corn evidently came from the experiment farm near where the bird was killed. As a whole the recent feeding of this male pheasant caused damage from an agricultural point of view.

Bird No. 5

Killed June 3, 1916, in a field of fall grain.

CROP CONTENTS

290 kernels of wheat and much chaff.

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GIZZARD CONTENTS

39 kernels of wheat
1 sunflower seed.
1 young hopper
5 leaf-beetles

The balance consisted of partly digested grain and ground-beetles.

The presence of so much chaff would indicate that the grain eaten was waste, in the eating of which no damage was done. The leaf-beetles devoured feed upon wild sun-flowers and are of no economic importance. The one beneficial act, the devouring of the grasshopper was off-set by the destruction of several ground-beetles. This bird can be considered as neutral in its recent feeding.

Bird No. 6

Killed 6 P. M., June 3, 1916, in a grain field across the road from a field of corn.

CROP CONTENTS

7 kernels of corn
Several nightshade leaves

GIZZARD CONTENTS

Two whole kernels of corn and partly digested corn together with green leaves.

The remains of what appeared to be a potato beetle was the only evidence of insects in the food of this bird.

In taking the corn from the field near where it was killed, this bird may have off-set all the good done in destroying the one potato-beetle. At most we can consider this individual as neutral in its feeding.

Bird No. 7

Killed in grain field across road from seed-beet field, 11:30 A. M., June 8, 1916.

CROP CONTENTS

Alfalfa leaves and sugar beet pulp constituted the whole contents of the crop.

GIZZARD CONTENTS

The only insects present were ground-beetles. Sugar beet pulp and green leaves composed the vegetable matter.

With the exception of the alfalfa which this bird ate, its recent feeding only can be considered as injurious.

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Bird No. 8

Killed Sept. 8, 1916, at 6 P. M., feeding on dry land 40 rods from nearest field which was grain stubble.

CROP CONTENTS

586 wild sunflower seeds
226 kernels of wheat
9 kernels of barley
11 kernels of oats
8 Rocky Mt. bee-plant seeds
3 unidentified seeds
No trace of insects

GIZZARD CONTENTS

15 kernels of wheat
361 wild sunflower seeds
1 Rocky Mt. bee-plant seed
1 Grasshopper

The grain eaten was undoubtedly all waste. In destroying the weed seeds and the hopper, considerable good was accomplished. This bird can be classed as beneficial in its recent feeding.

Bird No. 9

Killed Oct. 2, 1916, walking across a potato field near barley stubble. Time, 6 P. M.

CROP CONTENTS

135 kernels of barley
63 kernels of wheat
10 kernels of oats
441 wild sunflower seeds
453 *Polygonum* sp. seeds
40 Foxtail grass seeds
2 Rocky Mt. bee-plant seeds

GIZZARD CONTENTS

The gizzard contained the partly digested remains of the same kinds of seeds found in the crop, together with much ripe tomato pulp. Several leaves and 4 hoppers.

Since the grains eaten are undoubtedly waste, the large number of weed seeds and the hoppers constituting an element, the taking of which must be considered a beneficial act, places this bird's food largely in the class detrimental to agriculture. This bird is classed as beneficial.

Bird No. 10

The stomach of this bird was lost before the contents were examined, therefore no record can be given.

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Bird No. 11

Killed Dec. 8th, at 3 P. M., in a stubble field near waste land about a reservoir.

CROP CONTENTS

27 wild oats
268 kernels of wheat
1 winter larva of a blister beetle
4 hoppers (old dead insects)

GIZZARD CONTENTS

40 kernels of wheat
1 hopper (old dead insect)
100 unidentified weed seeds

In destroying weed seeds and wild oats, this bird rendered a service to agriculture. The only detrimental act was the eating of the blister-beetle larva. These beetles may do some damage in the adult stage, however the larvae are beneficial, those of the common species feeding on grasshopper eggs.

Bird No. 12

Killed Dec. 8th, 1916, 3 P. M., on lake shore.

CROP CONTENTS

43 kernels of wheat
5 hoppers (dead when eaten)

GIZZARD CONTENTS

1 dead hopper
1 Russian thistle seed
5 *Amaranthus* seeds
1 *Rumex* sp. seed
24 *Atriplex seeds*

Several nightshade seeds and berries.

The recent feeding of this bird did some good in the destruction of noxious seeds. There was no evidence of injury to agriculture in the stomach contents.

SUMMARY

In the following table the various kinds of foods are tabulated according to their relative bulks, the largest being No. 1 and the others relatively placed. Agricultural vegetable matter is any plants or parts of plants and seeds raised as field or garden crops in northern Colorado. Noxious vegetable matter is weed seeds or other parts of so-called noxious weeds. Neutral animal matter is any insect or other animal substance which is not of importance as a crop pest or of agricultural value in any way.

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Bird No.	VEGETABLE FOOD			ANIMAL			Bird Classed
	Waste	Agri-cultural	Noxious	Injurious Insects	Beneficial Insects	Neutral	
1	1			3	2		Inj.
2	3	1		4	2		Inj.
3		1	4	3	2		Inj.
4	2	1			3	4	Inj.
5	1		4	3	2		Neut.
6		1	3	2			Neut.
7		1			2		Inj.
8	2		1		3		Ben.
9	2	4					Ben.
10	No record						
11	1		2		4	3	Ben.
12	1		2			3	Ben.

The points worthy of note are:

1st. That the food of the ring-necked pheasant is largely vegetable matter. It is at least double in bulk the animal matter in those months when the most animal matter is taken. During the winter months very little animal matter is consumed.

2nd. That the insects devoured consist very largely of ground-beetles, nearly all of which are beneficial to agriculture.

3rd. The presence of potato-beetles in the stomachs of two birds indicate that where potatoes are extensively grown, the ring-necked pheasant might render a service in the destruction of this pest.

4th. The apparent liking for tomatoes and the fruits of related plants would indicate that tomatoes might be damaged to a considerable extent.

5th. The liking for young seedling sugar beets and the pulp of seed beets and commercial beets in the fall points toward the possibility of the pheasants being a source of injury to these crops.

6th. The corn pulling habit has already resulted in considerable damage. At present this crop suffers more than any other. In several instances the stand has been completely destroyed over considerable areas.

7th. Spring and summer feeding results in injury to field and garden crops. Winter feeding results in a benefit to agriculture because of the destruction of large numbers of noxious weed seeds.

8th. Feeding takes place quite locally. Both the males and females feed more locally during the breeding season than at other times of the year. The proximity of nesting places to such crops as corn, sugar beets and garden and small fruit crops will very likely result in heavy local damage.

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In studying this report it must be borne in mind that no birds were taken during January, February, March and April. It is possible that during the spring when cut-worms are very numerous, the pheasants do great good in the destruction of this pest.

Conclusion

If we were to judge the ring-necked pheasant by the evidence at hand, we would be forced to say that the value of these birds to agriculture has been over estimated. At best, it appears that the injury done at certain times of the season and in certain localities is off-set by the good done at others. There seems to be no foundation for the statements that this bird is a great enemy of grasshoppers.

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General Summary

W. L. Burnett

Summing up the two reports on the food habits of the fifty-nine pheasants taken, we find that the two reports harmonize well. The majority of Mr. Maxson's birds were taken near beet fields, or waste places, and show a smaller percentage of grain than ours, which were taken largely in or near grain fields. On the other hand, Mr. Maxson's birds show a larger percentage of weed seeds taken, which is not strange considering the conditions under which they were taken. Two of his birds had eaten beet pulp, and one, tomato.

With respect to the insect eating habits of pheasants, we may form the same general conclusions, from the two reports, viz., that they by no means show a preference for insect food, and are very indifferent to grasshoppers.

Our forty-eight birds took seven grasshoppers, and Mr. Maxson's eleven birds took eighteen. Eleven of the hoppers found by Mr. Maxson, and three by us, were old dry insects which had been picked up dead, leaving eleven as the total number of live hoppers taken by the fifty-nine birds at one meal.

None of Mr. Maxson's birds had taken cutworms, and ours had taken but three. His birds showed the same decided preference for wheat, taking five times as much of this grain as of all other grains together, barley being their second choice, the same as in ours.

In the weed seeds taken by Mr. Maxson's birds, wild sunflower heads the list, and black bindweed holds second choice, the same as we found in the forty-eight birds taken.

These investigations were carried on to obtain actual data on the food habits of the Ring-necked Pheasant in the Loveland-Ft. Collins section. The results are here recorded for farmers and all interested, that each may draw his own conclusions as to the economic importance of this bird as an inhabitant of the farming sections of the state.

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Circular 32 April, 1921

The State Entomologist Law *and* The Pest Law of Colorado

(Compiled April, 1921)

Office of State Entomologist
COLORADO AGRICULTURAL COLLEGE
Fort Collins, Colorado

THE BRADFORD PUB. CO., DENVER

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OFFICIAL STAFF

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GEORGE M. LIST.....Chief Deputy

WESLEY FOSTER.....Deputy in Charge Apiary Inspection

WILLIAM L. BURNETT.....Deputy in Charge Rodent Control

J. H. NEWTON.....Deputy in Charge Alfalfa Weevil Control

W. L. MAY.....Deputy in Charge Weed Control

WM. P. YETTER, JR.....Deputy

C. L. CORKINS.....Deputy

MABELLE G. THURLOW.....Clerk and Stenographer

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(CHAPTER 191 OF THE SESSION LAWS OF COLORADO FOR 1907, AS AMENDED BY CHAPTER 47 OF THE SESSION LAWS FOR 1909, AND AS AMENDED BY CHAPTER 131 OF THE SESSION LAWS FOR 1917, AND AS AMENDED BY CHAPTER 61 OF THE SESSION LAWS FOR 1919. COMPILED APRIL, 1921.)

The State Entomologist Law

AN ACT

TO PREVENT THE INTRODUCTION, IMPORTATION OR SPREAD OF INJURIOUS INSECTS AND PLANT DISEASES IN COLORADO; TO PROVIDE FOR THEIR EXTERMINATION WHEN FOUND IN THE STATE; TO REQUIRE THE INSPECTION OF NURSERIES, NURSERY STOCK AND ORCHARDS; TO CREATE THE OFFICE OF STATE ENTOMOLOGIST; TO REGULATE THE SALE OF INSECTICIDES; TO REPEAL CHAPTER FIFTY-FIVE (55) OF THE SESSION LAWS OF 1897; TO PROVIDE A QUARANTINE FOR NURSERY STOCK, POTATOES, AND OTHER OBJECTS INFECTED WITH INSECT PESTS OR PLANT DISEASES; TO PROVIDE FOR A QUARANTINE ON POISONOUS PLANTS; TO PROVIDE FOR THE CONTROL OF THE ALFALFA WEEVIL IN THE STATE; AND TO MAKE AN APPROPRIATION FOR CARRYING OUT THIS ACT.

Be It Enacted by the General Assembly of the State of Colorado:

SECTION 1. For the purpose of this Act, the Entomologist of the Colorado State Agricultural College is hereby declared to be State Entomologist, whose duty shall be, directly or through his deputies or Horticultural Inspectors, to carry out the provisions of this Act. The compensation of the State Entomologist shall be Five Hundred Dollars per annum in addition to his salary as Entomologist of the Agricultural College; his deputies and Horticultural Inspectors shall receive not more than Six Dollars per day, and Assistant Horticultural Inspectors Four and 50/100 Dollars a day in addition to their actual and reasonable expenses for time spent in carrying out the provisions of this Act, except, that the Chief Deputy, if employed by the year, may draw a regular salary of not to exceed $2,400.00 a year.

SECTION 2. The persons employed under this Act, aside from the State Entomologist, shall be the members of the State Board

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of Horticultural and the County Horticultural Inspectors, and deputies of the State Entomologist, whose duty it shall be to carry out the provisons of this Act; Assistant Horticultural Inspectors working under the general direction of Horticultural Inspectors, when necessary, and engaged by the Horticultural Inspectors, with the consent of the County Commissioners; and helpers, who shall be common laborers employed to aid in carrying out the provisions of this Act.

SECTION 3. The County Commissioners of any county, when petitioned by not less than twenty-five fruit growers of their county to appoint a Horticultural Inspector, shall make such appointment as soon as possible.

It shall be the duty of the State Entomologist to examine all persons appointed by the County Commissioners as Horticultural Inspectors, and if found competent and fully qualified to perform the duties of the office he shall issue to such applicant a license as a County Horticultural Inspector; no person shall act as Inspector unless he holds such license, which license shall certify to the competency of such applicant, and shall authorize him to act as County Horticultural Inspector for a period of two years from date; *Provided,* That no person engaged in the nursery business either as owner, as agent, employe or as salesman for any nursery or agent to sell trees, shall be eligible for the position of Horticultural Inspector.

SECTION 4. It shall be the duty of the State Entomologist, directly, or through his deputies or Horticultural Inspectors, to inspect all the nurseries, orchards and shade trees of the State each year, and when it seems necessary, to inspect potatoes, and other farm or garden crops or other articles whatsoever, for the purposes of determining whether or not any of them are infested with injurious insects or fungous or other plant diseases that are likely to be disseminated to the injury of others, and to carry out such experiments as he may deem important to determine the best methods of control for the pests and diseases with which he has to deal.

When a nursery, farm or other premises that has been inspected seems to be free from insect pests and plant diseases, the Entomologist shall, upon request, issue to the owner, renter or occupant, a certificate stating these facts. But, if any nursery stock, orchard or shade trees, potatoes, or other farm or garden crops or any objects whatsoever, be found to be infested with any serious insect pest or fungous or other plant disease that is likely to be disseminated to the injury of others, the owner or renter or person in charge of the infested or diseased property or premises must disinfect or destroy the same under the direction and to the satisfaction of the State Entomologist, or his deputy or Horticultural Inspector in charge, and at the owner's expense, unless the

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State Entomologist or Inspector in charge sees fit to remove, disinfect or destroy the infested or diseased articles himself.

SECTION 5. Every owner or renter or person in charge of a nursery in Colorado shall erect and maintain upon the premises, or in connection therewith, a suitable structure for the fumigation of nursery stock, buds and scions with hydrocyanic acid gas, and all stock, before leaving the nursery, must be fumigated with this gas, or otherwise treated, in accordance with printed or written instructions furnished by the State Entomologist or Horticultural Inspector in charge.

Every package, box, or bundle of nursery stock, buds, scions, or cuttings, that are sold or otherwise disposed of in Colorado by a nursery or a dealer in nursery stock, either within or outside the State, must bear a certificate signed by the owner or dealer certifying that the nursery stock, scions, cuttings, or buds, have been fumigated or otherwise disinfected in accordance with the laws of the State of Colorado. If nursery stock, scions, buds, or cuttings are brought into the State by private parties or a common carrier without a satisfactory certificate of disinfection, they must be fumigated with hydrocyanic acid gas or otherwise thoroughly disinfected by the Horticultural Inspector of the county where received before being delivered to the purchaser, and at the expense of the owner or party receiving the same; however, when in this Act it is directed that nursery stock, cuttings, buds, scions, potatoes or any articles or premises as enumerated in this Act shall be fumigated or disinfected, the owner of the infested property may, if he so requests, do the work of disinfection himself, under the direction and supervision of the State Entomologist, or Horticultural Inspector in charge, and to his satisfaction, and no fee or charge shall be made for such direction and supervision. A certificate of inspection or fumigation upon nursery stock, potatoes, or other articles, however, shall not deter the State Entomologist or a Horticultural Inspector from examining or seizing and disinfecting the same if found to be infested by living injurious insects or contagious diseases in any stage of development. No person or persons, either as owner, agent, servant, employe or common carrier, shall bring or cause to be brought into any county of the State of Colorado having a County Horticultural Inspector, from any district, county, state or foreign country, any trees, vines, shrubs, scions, cuttings or grafts or any other materials or objects that the State Entomologist may from time to time name as being liable to disseminate insect pests or plant diseases, without notice of their arrival at their destination at once to the Horticultural Inspector of the county; and such articles shall not be delivered to the consignee, planted, sold or in any way distributed until permission to do so has been given by the Horticultural Inspector of the county, who may detain such stock or articles only as long as it is necessary for proper inspection or disinfection.

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Under the provisions of the Postal Laws and Regulations providing for the terminal inspection of parcel post shipments of plants and plant products, the State Entomologist may establish certain points within the State for the inspection of such plants and plant products as he may rule are likely to disseminate insect pests or plant diseases.

The State Entomologist, or his deputy, or a County Horticultural Inspector, when the same is necessary and has been authorized by the Board of County Commissioners of the county, after notice to the owner or person in charge of same, shall spray, fumigate, disinfect or otherwise treat trees, shrubbery, potatoes, plants, buildings or other like property. Upon the completion of such work a statement of the cost and expense thereof with a description of the property upon which such work was done shall be filed with the Board of County Commissioners, who shall pay same without delay.

SECTION 6. Whenever the State Entomologist, his deputy, or a Horticultural Inspector has reason to believe, or has been credibly informed, that at any place within the State there exists or have been introduced or offered for sale plants, trees, shrubs, cuttings, buds, fruit, potatoes, or any other objects infested by injurious insects or plant diseases that are liable to be spread to the injury of others, it shall be his duty to make an investigation of the suspected articles and premises, and if they are found so infested, the State Entomologist, his deputy or the Horticultural Inspector of the county shall notify the owner or possessor, in writing, of the nature of the infestation, specifying the insects or diseases that have been found, and demanding that within a reasonable specified time, the infested goods, articles, potatoes or premises shall be disinfected. The owner of the infested property may choose whether he will have the infested property disinfected or burned, provided the case is not of such a nature that the State Entomologist or Horticultural Inspector deems it necessary that the infested property be destroyed by fire; and in such cases the State Entomologist shall, directly or through his deputy or a Horticultural Inspector, seize the infested property and burn it. If disinfection be decided upon and the possessor of the infested property refuses to disinfect the same in accordance with the instructions of the officer in charge, the State Entomologist or Horticultural Inspector shall take possession of the infested property and disinfect it, *at the expense of the owner,* said expense to be collected as provided for in Section Five (5)of this Act.

Each and every violation of any of the provisions of this Act, and each and every non-compliance with any notice or direction given by the Horticultural Inspector in charge under the provisions of this Act, shall be punishable by a fine in the sum of not less than Five Dollars, nor more than Five Hundred Dollars, and each and every day that any person, firm or corporation shall fail

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to comply with any notice in writing received from the State Entomologist, or Horticulaural Inspector in charge under the provisions of this Act, shall be deemed a separate offense.

SECTION 7. The State Entomologist, his deputy, or a Horticultural Inspector having jurisdiction, together with such help as they may need in the prosecution of their work, are authorized, during reasonable business hours, to enter upon or into any premises, land, buildings or places of business where they may suspect that infested or diseased plants, trees, shrubs, cuttings, scions, buds or other objects exist, for the purpose of inspecting, treating, cleaning or disinfecting the same, or otherwise carrying out the provisions of this Act.

SECTION 8. Horticultural Inspectors shall make a full report to the State Entomologist, at least once each month on the work done during this period. The State Entomologist shall file an annual report with the Secretary of the State Board of Agriculture, which may be published from the office of the State Entomologist, and which shall contain a summary of the work done during the year and an itemized account of moneys received and expended in carrying out the provisions of this Act, together with such additional information in regard to the work as may seem to him important.

Whenever the State Entomologist, his Deputy or Horticultural Inspector in charge, in their investigation shall find a section, or any portion, of the state to be infested with a serious insect or animal pest, poisonous or injurious plant, or plant disease, and in their judgment farm products, domestic animals, or other objects from that district or section would be liable to spread the insect or animal pest, poisonous or injurious plant or plant disease, into other sections to the injury of others, they, or any of them, may declare a quarantine against such section to prevent the transfer of such farm products, domestic animals or other objects from the quarantined area; also, whenever it is ascertained that insect or animal pests, poisonous or injurious plants, or plant diseases are likely to be introduced into Colorado by the importation of farm products, farm animals, or other objects, the State Entomologist may declare a quarantine against the importation of such farm products, domestic animals, or other objects.

SECTION 9. Horticultural Inspectors shall distribute to orchardists or other fruit growers such circulars and bulletins as shall be furnished them by the State Entomologist or State Board of Horticulture giving information as to the methods of destroying or keeping in check injurious insects or plant diseases, and they shall also collect information concerning the conditions of orchards, nurseries, vineyards and berry fields as the State Entomologist may direct, said information to be used by him in the preparation of his annual report.

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SECTION 10. It shall be deemed a violation of this Act for any one to sell in Colorado, insecticide poisons such as Paris green, London purple, white arsenic, arsenate of lime, arsenate of lead, acetate of lead, arsenite of zinc, cyanide of potassium, hellebore, pyrethrum powder, or any other materials or preparations sold or offered for sale, for the control of insect pests or plant diseases, that are diluted or mixed with other substances, unless the kind and amount of the adulterations or mixtures are conspicuously printed in the English language upon each and every package sold. Upon all packages of arsenate of lead or arsenite of zinc sold in paste form, the percentage of water, by weight, must be guaranteed.

The State Entomologist may inspect, examine and make analyses of insecticide, fungicide or other materials held or offered for sale within the State for the purpose of determining their purity, their strength and their value for the destruction of insects or plant diseases in any stage of their development. He shall have free access during all reasonable business hours upon or into any premises or structures to make examinations of insecticides or fungicide materials, and upon tendering payment therefor at the current value, may take any sample or samples for examination, analyses, or tests, the results of which may be published for the information of the public.

SECTION 11. The salary and expenses of the State Entomologist, and the per diem and expenses of his deputies in carrying out the provisions of this Act shall be paid out of the State Treasury, but the wages of the Horticultural Inspectors and their assistants shall be paid out of the treasuries of the counties where their work is performed in each case.

SECTION 12. The sum of fifteen thousand dollars ($15,000.00) per annum is hereby continually appropriated to pay the salaries of the State Entomologist, the salaries and per diems of his deputies and assistants, and to pay necessary expenses in traveling, printing blanks and circulars, and otherwise carrying out the provisions of this Act.

The State Auditor is hereby authorized to draw his warrants upon the State Treasurer for the sum herein appropriated upon the presentation of proper vouchers and the Treasurer shall pay the same out of any funds in the State Treasury not otherwise appropriated.

The appropriation herein made and its method of expenditure is declared to be in harmony with Section 12 of the Colorado Pest Act (Chapter 95 of the Session Laws of 1915).

SECTION 13. That all other acts or parts of acts, insofar as they are in conflict with this Act, are hereby repealed.

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SECTION 14. In the opinion of the General Assembly, an emergency exists; therefore, this Act shall take effect and be in force from and after its passage.

SECTION 15. The General Assembly hereby finds, determines and declares that this Act is necessary for the immediate preser vation of the public health and safety.

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(CHAPTER 95 OF THE SESSION LAWS OF COLORADO AS AMENDED BY HOUSE BILL 583, PASSED BY THE TWENTY-THIRD SESSION OF THE GENERAL ASSEMBLY, 1921. COMPILED APRIL, 1921.)

The Pest Law

AN ACT

TO PROVIDE FOR THE PROTECTION OF TREES, FRUITS, CROPS AND PASTURAGE AGAINST THE RAVAGES OF INSECTS, RODENTS, WEEDS AND PLANT DISEASES; TO PROVIDE FOR THE FORMATION OF PEST INSPECTION DISTRICTS, TO BE UNDER THE GENERAL AUTHORITY OF THE STATE ENTOMOLOGIST; TO AUTHORIZE THE COUNTY COMMISSIONERS TO DO CERTAIN PEST CONTROL WORK IN PEST DISTRICTS IN CO-OPERATION WITH THE STATE ENTOMOLOGIST; TO AUTHORIZE THE STATE ENTOMOLOGIST TO ENTER INTO AGREEMENTS WITH THE BUREAU OF BIOLOGICAL SURVEY, UNITED STATES DEPARTMENT OF AGRICULTURE, FOR RODENT CONTROL WORK; AND TO MAKE AN APPROPRIATION FOR CARRYING OUT THE PROVISIONS OF THIS ACT.

Be It Enacted by the General Assembly of the State of Colorado:

SECTION 1. The Board of County Commissioners of any county, whenever pest inspection districts, as hereinafter defined, are set aside in their counties, shall appoint a County Pest Inspector without unnecessary delay. It shall be the duty of the County Pest Inspector to carry out the provisions of this Act in said County as hereinafter provided, under the direction of the State Entomologist. A County Inspector shall not receive more than Eight Dollars ($8.00) per day, in the discretion of the County Commissioners, in addition to his actual expenses for the time employed in carrying out the provisions of this Act, said time not to exceed five months in each year, except with the consent of the County Commissioners, or when the offices of County Pest Inspector and County Horticultural Inspector are consolidated.

It shall be the duty of the State Entomologist to examine all persons appointed by the County Commissioners as Pest Inspectors, and, if found competent and fully qualified to perform the duties of the office, he shall issue to such applicants a certificate

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authorizing them to act as County Pest Inspectors. No person shall act as Inspector unless he holds such certificate which shall certify to the competency of such applicant, and shall authorize him to act as County Pest Inspector for a period of two years from date. In case of incompetency or neglect of duty, the State Entomologist shall have the authority to revoke such certificate at any time.

SECTION 2. The County Pest Inspector shall hold such office for a period of two years from date of appointment, unless sooner removed, provided that in any County where a Horticultural Inspector and Pest Inspector may be consolidated by the County Commissioners and held by the same person, such person shall draw only one per diem for his services at the rate set forth herein.

The County Pest Inspector, with the consent of the County Commissioners, may appoint such assistants as may be necessary to carry out the provisions of this Act, as hereinafter defined, and determine their salaries and expenses.

SECTION 3. Whenever the majority of the resident landowners within a township or a contiguous territory, not to exceed 36 square miles in area, desire to form a Pest Inspection District as hereinafter defined, they may file a petition for that purpose with the County Commissioners of the proper county. Said petition shall be addressed to the Board of County Commissioners of such county, and shall contain the number of the township or the boundaries of the proposed district, and a description of the land of each person signing such petition, according to government subdivisions, and shall state that the said township or district proposed to be formed into a pest inspection district has been invaded or is in danger of being invaded by grasshoppers, insects, prairie dogs, ground squirrels, or other rodent pests, weeds or plant diseases injurious to agricultural crops, trees, fruits or pasturage, naming the specific pests or diseases against which said petitioners desire to be protected. Such petition shall be signed by each landowner joining in the petition, by his own proper signature, and the date of the petition shall be the date of its filing in the office of the Board of County Commissioners. Any petitioner may revoke and cancel his signature to such petition at any time before filing the same, but not after such filing has been made.

Such petition must be filed with the County Commissioners during a regular or special session of the Board and must have the approval of the State Entomologist, and shall be verified under oath by at least one of the persons signing it, setting forth that the said petition was signed within ninety (90) days last preceding the making of said verification, and that all matters and things stated in said petition are true to the best of the knowledge and

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belief of the affiant, and that all signers have had an opportunity to read a statement made by the State Entomologist as to the work to be required for control or extermination of the pest or pests named.

A pest inspection district shall be deemed to have been formed under the provisions of this Act within five (5) days after the filing of the petition with the Board of County Commissioners, to continue for three (3) years unless said Board of County Commissioners, within said five (5) days, shall, by order entered of record, declare that said petition does not comply with the provisions of the Statutes, specifying the particular requirement which has not been complied with, and that no district has been legally formed.

Such petition may, in addition to the matters hereinbefore set out, and if the signatures of two-thirds of the resident land owners in such district be obtained thereto, but not otherwise, request the Board of County Commissioners, through its County Pest Inspector, to take charge of and supervise or do the work in connection with the control or extermination of the pest or pests named. The said Board of County Commissioners, if a pest district be created upon said petition in accordance with this Act, shall proceed during the existence of said district, through the said County Pest Inspector, to control or destroy such pests at the times and in the manner and by the aid of such means and additional help as the State Entomologist and County Pest Inspector shall recommend, and the Board of County Commissioners shall pay all expenses as they occur, which shall include the actual cost of material, labor and other necessary expenses, but not any items for compensating the deputies of the State Entomologist who shall supervise and direct such work, or the agents of the Bureau of Biological Survey of the United States Department of Agriculture who may, under co-operative agreement, assist therein.

When the said work shall have been completed throughout the said district, at any one time, the County Pest Inspector shall furnish a list of the landowners whose lands are included in said district, and their addresses, if known, and the lands owned by each, or the lands the owner of which is unknown, and the amount of said expenses due from each; but in computing the amount of such expenses due from landowners, the amount paid the County Pest Inspector shall not be considered; and when said expense bill and assessment has been approved by the Board of County Commissioners, said list shall be certified to the County Treasurer, who shall mail a notice of the amount thereof to every owner whose name and address is known, and he shall, thirty days after said notices are mailed, enter the amount of all such assessments, as are unpaid, at the proper places on his tax rolls; and such amounts shall become a lien upon said lands and shall be collected by the Treasurer in the same manner as taxes levied thereon. Said

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sums shall be increased by 5 percent if not paid upon mailing of notice, and shall bear interest at 1 percent per month from the date of entry upon the tax rolls.

SECTION 4. The salary of the State Entomologist shall be increased in the sum of Five Hundred Dollars ($500) annually for his services in administering this Act, and he shall directly, and through his deputies and County Inspectors, carry out its provisions, and he may appoint such deputies as shall be found necessary for said purpose; such deputies shall receive not more than Eight Dollars ($8.00) per day, in addition to their actual and reasonable expenses, and for the actual time spent in carrying out the provisions of this Act.

SECTION 5. It shall be the duty of the State Entomologist, directly or through his deputies or County Inspectors, to inspect all lands whereon he has cause to believe pests exist that are liable to spread to the serious damage of the community, whether such lands be located without or within pest inspection districts —together with the borders of said districts, at least once each year, at proper season, for the purpose of determining whether or not any of them are infested with such pests as are named in this Act or in the district petition, or any such as may be determined by the State Entomologist to be injurious to the community.

SECTION 6. Whenever the State Entomologist, his deputy, or County Inspector, has reason to believe, or has been credibly informed, that within the state there exists lands infested by pests which are liable to spread to the injury of others, it shall be his duty to make investigation of the suspected premises, and if they are found so infested, shall notify the owner or person in charge or control of such premises, in writing, of the nature, extent and location of the infestation and demand that within a specified time certain specified work shall be done on the infested premises for the extermination of the pests, and if the occupant of the infested property refuses or fails to do effective work on the premises in accordance with the instructions of the officer in charge, such officer shall take possession of the infested premises, and do the work necessary for the extermination of said pests, as provided in this Act. The reasonable and necessary expenses for doing such work shall be paid by the County without unnecessary delay, upon filing with the County Commissioners of the certificate of the State Entomologist showing the necessity for such work, the reasonable cost and expenses thereof, and giving a description of the land or property upon which the work was done. And, upon filing such certificate, such charges shall become a lien on the property treated—collectable as taxes by the County Treasurer upon the filing of such certificate with him in the event the property treated is real estate, or in the event of personal property it shall be effected by levy and sale after ten days advertising, as required by law upon the delivery of such certificate

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to any officer authorized by law to make levy and sale under execution; PROVIDED, HOWEVER, that either the State Entomologist or the County Inspector may, where cause exists outside of any pest inspection district as above provided, pursue the same remedies in all respects as to such lands and owners of lands outside of any such district the same as though embraced within a pest inspection district.

SECTION 7. Each and every violation of any of the provisions of this Act, or non-compliance with any notice or direction given by the inspector in charge under the provisions of this Act, shall render the offender liable in an action of debt for not less than Twenty-five Dollars ($25.00), and not more than Three Hundred Dollars ($300.00), and each and every day that any person, firm or corporation shall fail to comply with any notice in writing received from the inspector in charge under the provisions of this Act, shall be deemed a separate offense. If the land in question be within or without a pest inspection district and the defendant be found guilty, the Court shall also render judgment against the defendant for the cost and expense.

SECTION 8. The State Entomologist, or his deputy, or the County Inspector, having jurisdiction, together with such help as they may need in the prosecution of their work, are authorized during reasonable business hours, to enter upon, or into any premises, lands or places within or without any pest district in this State where they may suspect that such pests occur as are named in this Act or in the district petition or such as may be determined by the State Entomologist to be injurious to the community, for the purpose of inspecting, controlling and exterminating the same or otherwise carrying out the provisions of this Act. The County Inspector shall make a full report to the State Entomologist at least once a month, of the work done during that period.

SECTION 9. Notice of work required to be done may be served upon the owner, occupant or person in charge of any land, or in case the land is unoccupied, then upon any resident agent of the owner thereof. All public highways and all rights of way of railroads, ditches and reservoirs, and the owners thereof, shall be subject to the provisions of this Act. In case school land is embraced within the Pest Inspection District, the notice shall be served upon the State Land Board, and they shall be subject to all provisions of this Act. Notice or summons in any suit or proceeding may be served upon any person or corporation, in form and manner as provided by the Code of Civil Procedure.

SECTION 10. County Inspectors or their deputies, shall distribute to owners or occupants of premises in Pest Inspection Districts such information as to the methods of destroying or keeping in check grasshoppers, and other pests, and shall also collect such

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information concerning the condition of lands and premises in pest districts, as the State Entomologist may direct.

The State Entomologist is authorized to enter into such co-operative agreements with the Bureau of Biological Survey, U. S. Department of Agriculture, as will further the rodent control work of the State, and such agreements shall, as far as practical, encourage the control or extermination of these pests on National Forest, Indian Reserve or other national reserve lands that adjoin pest districts or uninfested agricultural or grazing lands, and extend the work of control or extermination where an organized effort is being made by landowners in co-operation with the County Commissioners and the office of the State Entomologist.

SECTION 11. The salary and expenses of the State Entomologist and the per diem and expenses of his deputies in carrying out the provisions of this Act shall be paid by the State Treasurer, but the wages of the County Inspector and their deputies shall be paid out of the treasuries of the counties where their work is performed.

SECTION 12. The sum of Five Thousand Dollars ($5,000.00) per annum is hereby appropriated to pay the salary of the State Entomologist and the per diem of his deputies, and to pay their necessary expenses in traveling, printing blanks and circulars, in experimentation in ways of controlling pests, and in otherwise carrying out the provisions of this Act. The State Auditor is hereby authorized to draw his warrants upon the State Treasurer for the sum herein appropriated, upon the presentation of proper vouchers, and the Treasurer shall pay the same out of any funds in the State Treasury not otherwise appropriated.

The funds herein appropriated and the appropriation made for carrying into effect the Horticultural Inspection Law as found in Chapter 191, Laws of 1907, are hereby consolidated and made a common fund for carrying into effect the aforesaid Act, and this Act, and to apply to the necessary expense of either or both Acts as herein provided.

SECTION 13. Chapter 150 of the Session Laws of 1911, approved June 1, 1911, and all other acts and parts of acts in conflict with this Act, are hereby repealed.

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Circular 33 May, 1921

KILL THE WHORLED MILKWEED THAT MENACES YOUR STOCK

W. L. MAY

The whorled milkweed in this pasture could be killed by fall plowing and the planting of winter wheat.

Office of State Entomologist
COLORADO AGRICULTURAL COLLEGE
Fort Collins, Colorado

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This plot of land was covered with a heavy stand of milkweed in 1918. It was plowed twice in the fall, and showed not over 5 percent milkweed in 1919.

This is a good way to kill whorled milkweed if the plowing is done in the fall and a winter wheat crop sowed.

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KILL THE WHORLED MILKWEED THAT MENACES YOUR STOCK.

Dangerous Plant Can Be Killed By Cultivation---How to Do It.

That whorled milkweed can be killed on tillable land by comparatively easy methods has been fully demonstrated. The methods outlined in this circular have proven successful not only in experimental plots but have given uniformly good results when put into use by farmers. The nature of the methods outlined prohibits their use on very rocky ground, on which the whorled milkweed often occurs. It is hoped that chemical means of eradicating such areas as occur on soil that cannot be cultivated will be worked out in the near future.

FALL PLOWING BEST METHOD TO USE

The procedure which has given the most uniformly successful results when put into operation by farmers is fall plowing of infested areas. This has proven efficient only on milkweed areas which have ***not*** been clean cultivated during the summer months preceding. Clean cultivation, or hoeing, during the summer months tends to cause the plants to root deeper and to reduce the efficiency of fall plowing.

The following procedure has been used by a farmer in the Grand Valley with success:

Nature of field: Young alfalfa heavily infested with milkweed.

First plowing—Middle of August, 1918.
Second plowing—About Sept. 15, 1918.
Followed with cover crop of winter wheat.
Winter wheat harvested July, 1919.
Estimated 90% milkweed killed.
Field plowed August, 1919.
Left lie over winter.
Field practically free from milkweed.
Planted to cultivated crop 1920.

This method with slight modifications has been successfully used by farmers in Mesa, Delta, and Montrose Countries. Some farmers have reported killing of the milkweed by plowing in October for two successive years. One man plowed under milkweed in his pasture in 1918 so that he could use the pasture for his sheep. He estimated 90 percent killed in 1919, and plowed again just before placing his sheep in the pasture in 1919. He reports no milkweed in 1920. Another case of eradication near Paonia was in an orchard which was plowed in late August, 1919, and sowed to a cover crop of oats in 1920. The milkweed was almost entirely killed.

From the results in the field and from experimental work done the following principles seem well established:

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1st Do not attempt to hoe or clean cultivate whorled milkweed during the summer. It merely spreads the weed and causes it to root deeper.

2nd Plow deeply in late summer or in the fall. The advantage of plowing in the late summer is that plowing can be done before seed ripening, thus preventing danger of reinfestation, though late plowed fields have not shown that this danger is very great.

3rd Follow this fall plowing with an ***uncultivated*** crop, winter wheat being probably the best crop to use, although spring grain may be used. The purpose is to occupy and shade the ground quickly.

4th Follow the harvesting of the ***uncultivated*** crop with another plowing.

5th In bad infestations it may be well to follow with another grain crop.

The above method has the advantage of keeping the ground in use while fighting the weed. Good results are not obtained unless some other plant which occupies all the ground is quickly established after the plowing of the milkweed. For instance, fall plowing followed by corn or potatoes is not so good as if followed by a grain crop. After the plowing, the ground should not be stirred up much and it needs to be shaded if the milkweed is to be kept in check.

SMALL PATCHES MAY BE KILLED BY HAND

Where the infestation is small, it may be cheaper or more convenient to dig the patches by hand. The digging should be done at the times recommended for plowing. This should be borne in mind: Good plowing stirs ***all*** the soil, it does not "cut and cover"; good digging should stir all the soil, and should not "cut and cover." The milkweed plant spreads underground, and there is often more of it below the surface than above. Very often there will be a foot of bare ground between one stalk and the next, but the soil below this apparently vacant foot of ground will be filled with roots. It is therefore worse than useless to merely dig up a chunk of soil where a green shoot appears, because not only is such work lost, but the milkweed is merely given a good cultivation and proceeds to do better than ever. The most efficient method is to start a trench at one side of the patch, and either with a spade or grub hoe "move the trench" across the patch, digging out the underground parts. This thoroughness of digging cannot be too strongly emphasized. One such digging is better than ten careless operations.

As in plowing, an effort should be made to establish on the ground as soon as possible another plant to occupy and shade the soil.

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CIRCULAR 34 JUNE, 1921

Twelfth Annual Report

OF THE

State Entomologist

OF COLORADO

FOR THE YEAR 1920

OFFICE OF STATE ENTOMOLOGIST
COLORADO AGRICULTURAL COLLEGE
FORT COLLINS, COLORADO

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CIRCULAR 34 JUNE, 1921

TWELFTH ANNUAL REPORT

OF THE

STATE ENTOMOLOGIST

OF COLORADO

FOR THE YEAR 1920

OFFICE OF STATE ENTOMOLOGIST
COLORADO AGRICULTURAL COLLEGE
FORT COLLINS, COLORADO

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OFFICIAL STAFF

CLARENCE P. GILLETTE.....State Entomologist
GEORGE M. LIST.....Chief Deputy
WESLEY FOSTER.....Deputy Bee Inspector
WILLIAM L. BURNETT....Deputy in Charge of Rodent Control
*CLAUDE WAKELAND.....
.....Deputy in Charge of Alfalfa Weevil Control
W. L. MAY.....Deputy in Charge of Weed Control
J. H. NEWTON.....Deputy
WM. P. YETTER, JR.....Deputy
MABELLE G. THURLOW.....Clerk and Stenographer

*Resigned March 1st, 1920.

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Colorado St. Entomologist
2-1930

Letter of Transmittal

To the Secretary of the State Board of Agriculture:

Sir:—In compliance with the laws of the State of Colorado, I have the honor to present herewith, for filing in your office, my Twelfth Annual Report as State Entomologist. It contains a summary of the work of the office for the past fiscal year.

C. P. GILLETTE,
State Entomologist.

Fort Collins, Colorado.
November 30, 1920.

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TWELFTH ANNUAL REPORT

OF THE

STATE ENTOMOLOGIST

OF COLORADO

C. P. GILLETTE, State Entomologist
GEORGE M. LIST, Chief Deputy

This report covers some of the more important phases of the work carried on under three acts referred by law to the Entomologist of the Colorado Agricultural College for enforcement. These acts are commonly known as the State Entomologist Act, formerly called the Horticultural Inspection Act, the Pest Inspection Act, and the Apiary Inspection Act. The first act, which was originally passed in 1907, makes the Entomologist of the Colorado Agricultural College, State Entomologist, and certain funds are furnished for the extension of the entomological work within the State. The law provides for certain inspection and regulatory work, including the inspection of all incoming nursery stock, the inspection of nurseries, and, as far as possible, the orchards, shade trees and field crops of the State, especially where there is reason to believe serious insect pests or plant diseases exist. Provision is also made for the issuance and enforcement of plant quarantines for the protection of any part of the State from serious pests that might be disseminated by unrestricted movement of products. The funds provided may also be used for educational and experimental work. These phases have been emphasized and most of the problems are being handled without a great amount of regulatory restriction. The work has been correlated as closely as possible with that being carried on with College and Experiment Station funds; in fact, several men are paid jointly from these funds.

In 1911, the Pest Inspection Act was passed, which was revised in 1915. It was made to supplement the State Entomologist Act and make it possible to take care of certain phases of insect pest control that could not be handled under the former act. It also provided for certain work in the control of rodent and weed pests. The two acts have been consolidated and operate as one.

The Apiary Inspection Act was passed in 1909. It is especially for the control and eradication of bee diseases. It

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also provides for carrying on educational and experimental work in the apiaries of the State.

All of these laws are so drawn that the work may be carried on through co-operation with the counties through county inspectors. This system has been working very effectively, as it brings about county co-operation where there is a real need for work connected with pest control. It has also lightened the burden upon the State, making the smaller unit of government pay the expense where control work is done. This is a logical plan, as it places the large portion of the burden upon those who receive the greatest benefit.

Under this system, the county men, who are paid by the county commissioners of the various counties, can do a large portion of the regulatory work, thus leaving the time of the state men for more educational and research work in connection with the various problems that must have attention, and it is often found that the two latter phases of the work are the most important, even in carrying out the regulatory phases, as very few pest problems have been sufficiently worked out to enable the men in the field to lay down definite regulatory policies. Even if such work has been done, it often takes considerable effort to get this information before the people who are affected.

The county inspectors are appointed by the county commissioners upon petition of the people of the county. They must pass an examination given by the State Entomologist and are subject to removal by the State Entomologist. The State Entomologist Law provides for the appointment of county horticultural inspectors, the Pest Law for county pest inspectors, and the Apiary Inspection Law for county apiary inspectors. In practically all cases where the two former officials are appointed, the offices are consolidated and held by a single person.

The amount of time these inspectors put in depends upon the conditions within the counties. Some counties have men employed for full time, while others have them only to handle certain problems, as the inspection of the incoming nursery stock, or the handling of some special pest problem such as prairie dogs, codling moth or San Jose scale.

The apiary inspectors rarely give more than a portion of the summer months to their work, as they can only do inspection of the apiaries during the working season of the bees.

The State Entomologist, who is also the head of the Department of Zoology and Entomology of the Agricultural College, and Entomologist for the Agricultural Experiment Station, has had time to do little more than consult with the various workers, and to establish, in a general way, the policies of the office.

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The Chief Deputy has given a considerable portion of his time to the general supervision of the work, and to keeping in touch with the work of the various county men. A great deal of time has also been given to the general correspondence that naturally comes through the office. Special attention has been given to the Mexican bean-beetle and the codling moth.

Mr. Wesley Foster has been in charge of apiary inspection, but, on account of lack of funds, has been able to give only a small part of his time to this work; consequently, it has been necessary for most of this work to be carried by the county apiary inspectors without a great deal of supervision.

Mr. W. L. Burnett has given his time to rodent control, special emphasis having been placed on the destruction of prairie dogs. He was assisted during the spring and summer months by Mr. Earl Hoffman. Practically all of their work was done in counties that employed county pest inspectors, and a great deal was accomplished.

The only important change in the official staff during the year was the resignation of Mr. Claude Wakeland, who had been stationed at Paonia in charge of the Alfalfa Weevil Investigations, to take up the work of Extension Entomologist for the University of Idaho. Mr. J. H. Newton, who had assisted Mr. Wakeland in the alfalfa weevil work, and had been doing some special codling moth work at Paonia, was placed in charge of the two lines of work. We were very fortunate in having a man experienced in alfalfa weevil investigations to take the work without interruption.

Mr. Newton was assisted during the spring and summer months by Mrs. A. J. Cady, and Mr. Jerome Martin. Mrs. Cady gave practically all of her time to life-history studies under Mr. Newton's direction. Mr. Martin assisted in the life-history and field work.

Mr. W. L. May has been stationed at Paonia giving special attention to the control of the whorled or poison milkweed. His report on this work is given on another page.

Mr. Wm. P. Yetter, Jr., has been stationed at Canon City, where he has given special attention to the fruit-tree leaf-roller control. This has been carried on in co-operation with Mr. D. S. Moore, the County Horticultural and Pest Inspector, Mr. Yetter has also carried on some special codling moth investigations, and has done considerable work in connection with the relation of the growth of the fruit to the codling moth spray problem.

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COUNTY INSPECTORS

Following is a list of the county horticultural and pest inspectors. A list of the county bee inspectors is given elsewhere. Those with no asterisk following their names are pest inspectors; those with an asterisk are horticultural inspectors, and those with two asterisks are acting as both horticultural and pest inspectors.

Counties	Inspectors	Deputies	Addresses
Adams	Waldo Kidder	W. E. Denman	Brighton
Boulder	T. B. Holman*		Boulder
Arapahoe	J. T. Robertson		Littleton
Delta	R. S. Purtee*		Paonia
Delta		Roy Gregg*	Delta
Denver	G. A. Klaiber*		Denver
Douglass	Raymond Miller		Castle Rock
Elbert	A. W. Aicher		Kiowa
El Paso	F. P. McKown*		Colorado Springs
Fremont	D. S. Moore*		Canon City
Larimer	D. C. Bascom		Fort Collins
Larimer	I. J. Noble*		Loveland
Lincoln	Scott Wisner		Hugo
Logan	J. E. Morrison		Sterling
Mesa	L. E. Jaymes**		Grand Junction
Montezuma	G. P. Newsom**		Cortez
Montrose	L. E. Ross**		Montrose
Montrose	L. W. Willis		Nucla
Otero	W. F. Droge		Rocky Ford
Otero	E. N. Berry*		La Junta
Ouray	B. B. Slick		Ouray
Pueblo	J. N. Salter*		Pueblo
Routt	J. C. Hale	B. F. Butler	Steamboat Springs
Washington	Wm. Geisert	John Hanson	Gary
Prowers	Morgan Sweitzer		Lamar

INCOMING NURSERY STOCK

The State Entomologist Law provides that each package of nursery stock coming into Colorado must bear a certificate showing that the nursery from which the shipment originated has been inspected within the past year by a duly authorized inspector and found free from especially injurious insect pests and plant diseases, and that each package bear a certificate showing that the hardy stock has been fumigated with hydrocyanic acid gas. The law also provides for the inspection of all such shipments of nursery stock upon arrival in all counties where county horticultural inspectors are employed. In such counties shipments cannot be delivered by the express or freight offices without a certificate of release from the county horticultural inspector. The more important horticultural counties of the State have provided for such inspection. Following is a summary of the nursery stock thus inspected by the county horticultural inspectors during the year.

Total shipments	620	Shade trees	34,387
Totals of all classes of nursery stock:		Blackberries, raspberries, and dewberries	14,819
Apples	23,656	Ornamental shrubs	41,210
Pears	13,954	Seedlings	5,500
Peaches	18,801	Miscellaneous	72,288
Plums, prunes, apricots	7,716		
Cherries	37,700	Grand Total	309,224
Grapes	11,513	Plants condemned	1,848
Currants and gooseberries	27,680		

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While this includes the bulk of the nursery stock coming into the State during the past year, it is unfortunate that the people in some counties do not realize the importance of this work to the extent of petitioning the county commissioners for the appointment of a county horticultural inspector. Such counties run the risk of not only allowing the entrance of a pest that may prove a menace to the county, but they also weaken the work in the counties that are providing this protection.

Another weakness of our present system of nursery stock inspection is that we are unable to inspect the shipments coming in by parcel post. More and more shipments are coming into the State through this channel. While it is true that many such shipments are small, it is also true that the amount of danger cannot be judged by the size of the shipment, as often the smaller shipments are a greater source of danger than the larger ones that come from well-organized nurseries. While many of the parcel post shipments come from the larger nurseries, it is very noticeable that many also come from home planting and from people that act only as dealers, and often pick up their nursery stock wherever it may be bought cheapest. It is a safe statement that the nursery stock coming in by parcel post is somewhat inferior to that coming in through the other channels. It is hoped that in the near future arrangements can be made for the inspection of all such shipments coming into the State.

The amount of nursery stock coming into the State during the past year has been the smallest since inspection work was inaugurated. This has been brought about by a number of causes, not the least of which has been the high prices charged for the nursery stock, due to the great shortage which exists all over the country. The scarcity of nursery stock has made a tendency among certain nurseries and dealers to ship stock that has not been up to the standard we have received during other years. However, as a general thing, the stock has been of good quality. No pests of an unusual nature have been intercepted. Crown gall and borers were the two principal causes for the destruction of the plants that were condemned. All inspectors are instructed to watch especially for all scale insects and for all serious pests such as the brown-tail and gypsy moths that have not yet become established within the State. Where only an occasional plant is infested or infected with an insect or plant disease such as borers or crown gall, the inspectors are instructed to destroy these individual trees, unless they constitute a considerable portion of a shipment; then they are to notify the consignor of the condition of his shipment and ask his wishes in regard

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to its disposition. Shipments containing serious pests which have not yet become established within the State are usually destroyed or returned immediately to the consignor.

Co-operation with the Federal Horticultural Board in the inspection of nursery stock coming from foreign countries, has been continued. All inspectors are requested to report immediately any conditions that should come to the attention of the Federal Board. The amount of nursery stock from foreign countries coming into the State has been unusually small, due largely to financial condition and to the conditions brought about by the World War. It has been almost impossible for the nurserymen and florists to secure foreign stock.

NURSERY INSPECTION

The following is a list of the nurseries of the State to which certificates have been issued during the past year authorizing them to sell and ship nursery stock.

Braun, J. G., Nursery, Denver.
Broadview Nursery, Golden.
Colorado Gardens, Colorado Springs.
Colorado Nursery Company, Loveland.
Columbine Nursery Company, Denver.
Denver Nursery Company, Denver.
Denver Wholesale Florist Company, Denver.
Elitch Gardens Company, Denver.
Globe Greenhouses, Denver.
Grand View Nursery, Wheatridge.
Guthiel Park Nursery, Aurora.
International Nursery, Denver.
Mauff Floral Company, Denver.
Northern Nursery Company, Denver.
Northern Colorado Nursery Company, Fort Collins.
Paul Oske Nursery, Aurora.
Pike's Peak Floral Company, Colorado Springs.
Park Floral Company, Denver.
Patrick Lee and Sons Nursery, Colorado Springs.
Roberts Rose Company, Denver.
Rockmont Nursery, Boulder.
Roselawn Cemetery Nursery, Pueblo.
Sutherland Nursery Company, Boulder.
Standard Nursery, Greeley.
Trimmer, T. H. and Son. Denver.
Weld County Nursery, Greeley.
Wilmore, W. W., Nursery, Denver.
Walker, Mrs. S. B., Denver.

Comparatively little nursery stock is propagated within the State. Most of our nurseries are rather small, and grow stock largely for local use. A large percentage of the business is devoted to the growing of ornamental stock. Due to an increased demand for ornamental stock and a shortage of nursery stock in general, most of the nurseries of the State have received better care during the last year than formerly.

The more important insect pests and plant diseases found during the nursery inspection were the elm scale, cottony maple scale, oyster shell scale, fruit-tree leaf-roller, peach borer, pine leaf scale, flat-headed apple-tree borer,

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various species of plant lice, blister mites, red spider, fire blight, poplar canker, and crown gall.

No certificates were withheld on account of the condition of the nurseries, but in a number of cases, it was necessary to require some special work or some special treatment of the stock for the protection of the purchaser. All nurseries are required to maintain fumigating houses for the fumigation with hydrocyanic acid gas of all the hardy stock leaving the nursery.

WESTERN PLANT QUARANTINE BOARD

During June, the Chief Deputy attended a meeting in Salt Lake City of the Western Plant Quarantine Board. This Board consists of one representative from the Plant Quarantine and Inspection Departments of the eleven states west of the Rocky Mountains, the Territory of Hawaii, Province of British Columbia and Lower California. Important problems in regard to plant inspection and quarantine work were discussed. While the Board has no power to bind any of its members, the full discussion and acquaintanceship that come from the annual meetings is doing a great deal to bring about uniformity in the plant inspection and quarantine work. A good example of the work of the Board is shown in the uniformity that has been brought about in the alfalfa weevil quarantines issued by the various states. The subject of a type of organization for the best results in plant inspection and quarantine work was thoroughly discussed. Many states are beginning to favor the establishment of central inspection points for the inspection of the incoming nursery stock. They feel that this would enable the states to handle this work with less damage to the nursery stock and less delay, and it would enable them to provide better trained men for the work, as fewer men could handle the work under this plan. British Columbia now has a similar plan in operation that is very highly spoken of.

PLANT QUARANTINES

A total of eleven plant quarantines has been issued. Of these only five are now in effect. These are:

No. 1—The Potato Tuber Moth: This forbids the importation of potatoes from the State of California that are infested with the potato tuber moth.

No. 7—Alfalfa Weevil: Regulating shipments of hays and straws from the states of Utah, Idaho and parts of Wyoming and Oregon.

No. 8—On account of Black Stem-Rust: This forbids the importation or sale within the State of all common barberry *(Berberis vulgaris)*, and its horticultural varieties.

No. 10—Alfalfa Weevil: Regulating the hauling and shipping of hays and straws from the County of Delta, and parts of the counties of Gunnison and Montrose.

No. 11—White Pine Blister Rust: This forbids the importation of all five-leaved white pines and all currant and gooseberry plants from all states east of and including the states of Minnesota, Iowa, Missouri, Arkansas and Louisiana.

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ANALYSES OF INSECTICIDES AND WEED KILLERS

During the past season, considerable burning resulted to a number of apple orchards near Paonia, apparently from the arsenical insecticides used. An investigation by J. H. Newton revealed the fact that practically all, if not all, of the severe burning was in orchards where washing powders had been used in combination with the insecticide, to act as a spreader, contrary to all recommendations. The burning to the foliage seemed more severe where there was injury from the blistermite, which was very common in the section.

In order to check on the quality of the arsenicals being used in the section, a number of samples were taken and analyzed by the Chemistry Department of the Agricultural Experiment Station. The analyses of the samples of calcium arsenate, zinc arsenites and magnesium arsenate were made in connection with the investigational work on the control of the Mexican bean-beetle, while those of the weed killers were in connection with work for the control of the "whorled" milkweed.

ANALYSES OF INSECTICIDES

Number	Arsenic	Equivalent to As_2O_5	Soluble As_2O_3	Moisture
	%	%	%	%
1	18.82	28.98	0.10	0.39
2	20.06	30.89	0.10	0.21
3	19.05	29.34	0.20	0.47
4	18.56	28.58	0.10	0.44
5	19.73	30.38	0.10	0.32
6	20.36	31.36	0.20	0.27
7	19.26	29.66	0.10	0.19
8	20.29	31.25	0.10	0.17
9	20.48	31.59	0.10	0.18
10	29.39	45.22	0.05	1.87
14	21.56	33.18	0.10	4.14
15	20.40	31.39	0.05	0.23
		As_2O_3		
11	25.58	33.93	0.05	0.87
12	30.78	40.82	0.15	0.10
13	30.07	39.88	0.10	0.16

ANALYSES OF WEED KILLERS

Number	Solids at 115 deg.	Arsenite As_2O_3	As_2O_5
1	53.75%	1 c.c.=0.3757 gram.	1 c.c.=0.00144 gram
2*	62.29%	1 c.c.=0.4533 gram.	1 c.c.=0.01065 gram

*Contained a small amount of creosote-like substance.

INSECTICIDES

No.1—Corona dry arsenate of lead taken from original container at Mr Gonner's ranch, Paonia. Had been used at the rate of 6 pounds to 200 gallons of water, plus 2½ pounds of Swift's Soap Powder. The burning on foliage was very severe.

No. 2—Dry arsenate of lead, brand of material unknown. Taken from original container at the Fred O'Bannon orchard. Had been used at the rate of 5 pounds to 200 gallons of water, plus 2 or 3 pounds of Swift's Soap Powder. Considerable burning on trees.

No. 3—"Rex" dry arsenate of lead. Taken from original container at the North Fork Fruit Growers' Association.

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No. 4—"Rex" dry arsenate of lead. Taken from original container at the Union Fruit Association.
No. 5—Sherwin Williams' dry arsenate of lead. Taken from original container at the Union Fruit Growers' Association.
No. 6—Corona dry arsenate of lead. Taken from original container at the Earl DeWoody orchard. Slight burning on foliage. Blister mite injury severe.
No. 7—Glidden's dry arsenate of lead. Taken from original container at the North Fork Fruit Association.
No. 8—Latimer's dry arsenate of lead. Taken from original container at State Entomologist's office, Paonia.
No. 9—Corona dry arsenate of lead. Taken from original container at the Paonia Fruit and Supply Co.
No. 10—Corona dry calcium arsenate. Taken from original container at office of State Entomologist, Fort Collins.
No. 11—Grasselli dry zinc arsenite. Taken from original container at office of State Entomologist, Fort Collins.
No. 12—General Chemical Co. dry zinc arsenite. Taken from original container at office of State Entomologist, Fort Collins. During three years experimental work on the control of the Mexican bean-beetle, this was the only sample of zinc arsenite to cause severe burning to beans.
No. 13—California Spray Chemical Company's dry zinc arsenite. Taken from original container at office of State Entomologist, Fort Collins.
No 14—Dow Chemical Company. Dry magnesium arsenate. Taken from original container at office of State Entomologist, Fort Collins.
No. 15—Latimer's dry arsenate of lead. Taken from original container at the Office of State Entomologist, Fort Collins.

WEED KILLERS

No. 1—"Key Weed" Weed Killer. Liquid. Taken from original container of material purchased for experimental work, Paonia.
No. 2—Atlas "A" Weed Killer. Liquid. Taken from original container of material purchased for expermental work, Paonia.
It will be noticed that the killing property of these "weed killers" is wholly arsenic in soluble form.

NOTES ON INSECT PESTS

THE WOOLLY APHIS, *Eriosoma lanigera* Hausm.

This aphid is common in all the apple-growing sections of the State, and undoubtedly does considerable damage to especially susceptible varieties, as Missouri Pippin and a few others.

We find no reason to think that the presence of the American elm in apple-growing sections has any perceptible influence upon the abundance of this insect. We are informed that in some of the apple-growing sections of Utah, California and Australia, where the woolly aphis is very abundant, the American elm does not occur.

THE COLORADO POTATO-BEETLE, *Leptinotarsa decemlineata* Say.

This striped potato beetle that was considered for many years to be the worst potato pest in the country is seldom complained of in Colorado any more. It has never invaded the potato-growing regions of the Western Slope, the Continental Divide continuing to act as an impassable barrier.

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THE MELON APHIS, *Aphis gossypii* Glov.

Melons, canteloupes and cucumbers have suffered rather seriously from the attacks of this aphis the past season in nearly all sections of the State where they are grown east of the mountains, but the injuries were particularly severe in the lower Arkansas Valley, where in conjunction with the melon rust, the vines were completely killed in most of the fields when the crop was about half harvested. As a result, very few melons of good quality were harvested.

FLEE-BEETLES

Each year brings numerous reports of injury to certain garden and field crops from the flea-beetle. While a number of species exist in the State, *Epitrix cucumeris* Harr and *Systena taeniata* Say, are the most numerous and are responsible for most of the injury to cultivated crops. They feed upon a large variety of plants but their work is especially noticeable upon the potato, tomato, peppers, beans, turnips, radishes and egg plant. The greatest loss comes from their work upon potatoes. The plants are often seriously injured by the numerous, characteristic, small holes eaten in the leaves by the adults, and the tubers are roughened by the work of the larvae, where they feed by making shallow tunnels just under the skin, or by making pits that may be from one-sixteenth to one-eighth of an inch deep. These blemishes are called "worm tracks" by the growers. The loss in the Weld County potato-growing section is often quite heavy from this injury. No doubt the feeding of the larvae on the stems and small rootlets of the various plants often checks the growth.

THE SQUASH BUG, *Anasa tristis* De G.

If we could judge by the number of inquiries coming to the State Entomologist, we would have to conclude that the "Squash Bug" is about the most pestivorous insect in Colorado, but the writer has yet to see many squash vines in the State that were being seriously injured by it directly. It is undoubtedly instrumental, however, in carrying the germs of *Bacillus tracheiphilus* E. W. Smith, from plant to plant, causing vine wilt, which is very common in the State.

The Squash Maggot, *Cyrtonema stabulans,* is also a common cause of the wilting of winter squashes, and the injury is also blamed upon the squash bug in nearly every case.

THE BLACK BEAN-APHIS, *Aphis medicaginis* Koch.

This is a very common species on sweet clover, *Astragalus* species, *Kochia* and Russian thistle, and when common on

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these plants, is usually very abundant on dwarf lima beans grown in gardens.

HARLEQUIN CABBAGE BUG, *Murgantea histrionica* Hahn.

The past season has been a very notable one in the very unusual occurrence of the Harlequin Cabbage Bug in eastern

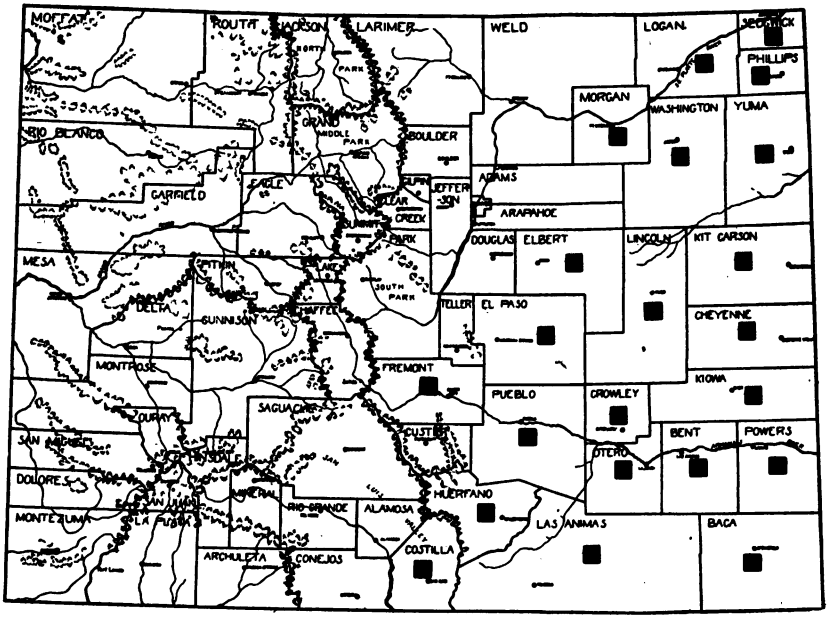

Plate I. Map showing counties from which letters were received during summer of 1920 concerning the Harlequin Cabbage Bug. Infested counties are marked with black squares.

Colorado. It probably occurred in noticeable numbers in every county east of the foothills, and extended somewhat into the foothills in the southern portion. This office made no effort to get reports on this insect. The black squares on Plate 1 mark the counties from which voluntary inquiries came to the State Entomologist concerning this pest. More inquiries came during last summer than during the 29 preceding years combined. The bugs were abundant as far west as Canon City, in Fremont County, and considerable damage was done to gardens as far north as Julesburg in the extreme northeastern corner of the State.

If it is true that this insect does not survive the winter north of the southern Colorado line, then it migrated northward approximately 300 miles, and covered an area of approximately 40,000 square miles in sufficient numbers to be consider-

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ed injurious over most of the area where gardens were planted.

One unique instance of control was reported to this office by Mr. O. S. Raynor, a specialist formerly with the Extension Service of the Colorado Agricultural College. The bugs appeared in such numbers in a truck garden at Hugo that the gardner concluded he must kill them or lose his garden vegetables. He thoroughly sprayed the garden with paris green to find that it had no effect. Thinking that the poison might be more effective if first steeped, and not knowing what else to do, he boiled the Paris green and sprayed the garden the following evening after a hot day, and, to his great joy, nearly every bug was dead the next morning. Evidently the boiling of the Paris green dissolved much of the arsenic, as the treatment burned the treated plants very badly. Probably the bugs regaled themselves by sipping from the drops of spray and in so doing were poisoned. We have Mr. Raynor's statement that he saw the dead bugs in great numbers the day following the treatment, and pronounced it a great success, so far as killing the insects was concerned.

THE ROSY APPLE APHIS, *Aphis sorbi* Kalt.

This serious pest to apple orchards is becoming quite generally distributed in the orchard sections about Grand Junction and promises to become a first-class pest, unless concerted efforts are made to control it. There has been a small infested area in the vicinity of Paonia, Delta County, for several years, but, for some reason, the lice have not spread much nor have their injuries been of much importance. This may be due, in part at least, to an almost complete absence of plantains, and especially the narrow-leaved variety, which is said to constitute the favorite summer host plant.

THE GREEN APPLE APHIS, *Aphis pomi* De G.

This aphid occurs in all the apple-growing sections of the State. It is an apple pest of much importance, but fluctuates greatly in number from year to year. A very small percentage of the eggs hatch in any year. It is common to find no early-summer lice occurring on trees where many of the water sprouts and rapidly growing twigs were literally blackened by eggs laid the previous fall.

THE IMPORTED CURRENT SAWFLY, *Pteronus ribesii* Scop.

During the past few years, this arch destroyer of the foliage of currant and gooseberry bushes has been quite widely disseminated in the section lying between Longmont and

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Fort Collins in northern Colorado, but has never been reported from other sections of the State.

THE ASPARAGUS BEETLE, *Crioceris asparagi* Linn.

This office first became aware of the presence of this beetle some four or five years ago in gardens at Boulder, Colorado. As yet, we have not learned of its presence in any other section of the State.

THE ROSE LEAF-HOPPER, *Typhlocyba rosae* Linn.

This is a very common pest in the apple orchards, often doing considerable damage to foliage and soiling the fruit so as to injure its sale. It is a serious pest on rose foliage in nearly all parts of the State every year.

THE GRAPEVINE LEAF-HOPPER, *Typhlocyba comes* Say.

While there are very few grapes grown in the State, the Virginia creeper, which seems to be especially favored as a host, is a very common vine upon houses and other buildings, and it often suffers very severely from this insect, which bleaches the leaves and causes them to die and fall. The form most common is *coloradensis* Gill.

THE PEAR-LEAF BLISTER-MITE, *Eriophyes pyri* Pagen.

This mite does no serious damage to pear foliage in the State, but is becoming a serious pest to the apple orchards, some varieties, notably the Jonathan, being much more attacked than others. Lime-sulphur sprays have been very successful in its control.

WESTERN WHEAT-STEM MAGGOT, *Hyalomyia cerealis* Gill.
(Plate II.)

A few complaints of serious damage to wheat from this insect come to this office nearly every year, and nearly always from the northern portion of the State. Usually the cause of the injury is not noticed until the maggots are well advanced and often they have nearly all left the grain before news of the injury reaches us. The damage is done quite early in the season, usually about the last week in April.

The following original description is from Bull. 94, p. 14, 1907, Colorado Agricultural Experiment Station.

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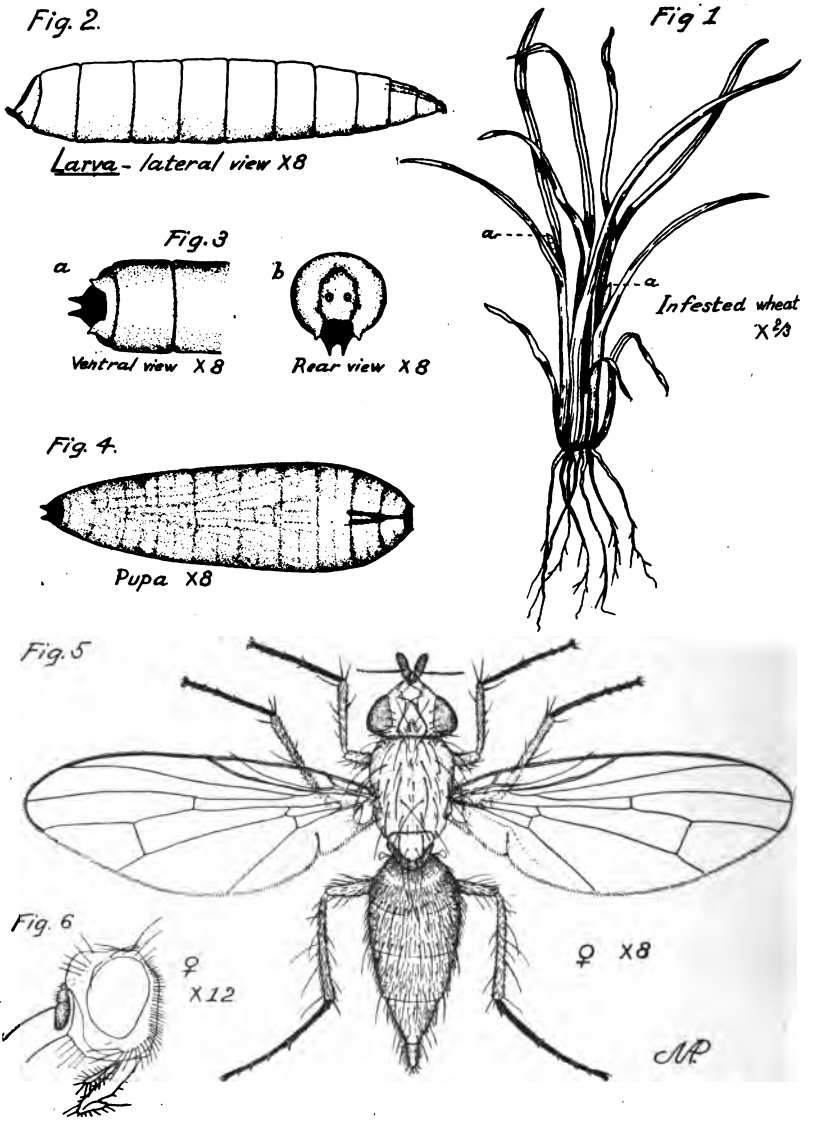

Plate II. Western Wheat-Stem Maggot, *Hyalomyia cerealis* Gill. **Fig. 1,** Wheat plant showing maggots at aa; 2 and 3, ventral and rear views of maggot; 4, puparium, ventral view; 5, adult female; 6, side view of head of female. Original, M. A. Palmer, Delineator.

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WESTERN WHEAT-STEM MAGGOT, *Pegomyia cerealis, n. sp.* *

"The maggots are dirty yellowish white in color and measure between 6 and 7 mm. in length by 1.5 to 1.75 mm. in diameter. At the small or anterior end the two jaws show distinctly and at the posterior end the two spiracles are black and above them is a shining plack plate or chitinous piece which terminates in two short stout spines. The puparium is like the maggot in length and thickness; it is straw-yellow at first but darkens rapidly as the time for the emergence of the fly draws near. The black plate and spines of the maggot also show plainly and the extreme anterior end is blackened.

"The Adult Flies. Female: length about 5.5 mm. exclusive of ovipositor. Color of head and body rather uniform light gray, set with large and small black bristles that arise, each from a small black spot. Eyes dark reddish brown, naked, separated in front by a space nearly equal to the diameter of an eye; antennae black, the aristae also black and slightly plumose to the tips. Color of head like that of thorax except for a slight golden tint upon the face. There are five moderately stout bristles in a row parallel with the inner margin of the compound eye on either side and another row of about 20 of these bristles along the posterior border of each eye, the two at the upper angle of the eye being larger than the others. On the thorax there may be distinguished one median and, on either side, two lateral darker stripes which are quite distinct, and upon each of which a row of stout black bristles arises. Scuttelum with four setae, two very stout ones near the tip and one not so large near each posterior angle. Abdomen rather thickly set with stout black setae of moderate size, the largest ones arising from near the posterior margin of the segments. Femora cinerous like the body except at the knees where they change to light amber which is the color of all the tibiae; the tarsi of all the legs are deep black. The wings are hyaline, tegulae and sub-tegulae small and nearly equal and amber in color, as are all the large veins.

"The males differ from the females in being of a dark cinerous brown color. The femora are also of the same color and the tibiae are much darker than in the female. The eyes are very much larger, being subattingent in front of the ocelli.

"Described from nine males and ten females bred from stems of winter wheat."

The adults of this species seem very close to *fusciceps*, Zett., but those we have reared are readily separated from that species by the light color of the femora and tibiae, especially in the females. The large bristles bordering the inner margins of the eyes vary from 5 to 7 in number.

WIREWORMS

An increasing number of complaints concerning wireworm injuries to grain, potatoes and other crops have been coming to the office of the State Entomologist for some years. While examples of both the true wireworms, *Elateridae*, and false wireworms, *Eleodes* sp., have been received, the latter have predominated. From the evidence already in hand,

*Specimens submitted to C. W. Johnson were referred to Mr. Coquillet, who determined them, '*Near Pegomyia ceptorum*, but apparently distinct.' "

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there can be no question but that the false wireworms, at least, are occasioning considerable losses to wheat and other grains, and especially in the dry-farming areas of the eastern portion of the State.

THE IMPORTED CURRANT-WORM, *Pteronus ribesii* Scop.

To the present time, this insect is only known in Colorado in the district lying between Longmont and Fort Collins and it lacks much of covering all of this territory. Where it occurs it is quite destructive to the foliage, its habits being the same as in the Eastern States.

THE CURRANT-FLY, *Epochra canadensis* Loew.

This fly seems perfectly at home in eastern Colorado where it freely attacks the wild currants and gooseberries in the foothills as well as the cultivated varieties in the gardens. It fluctuates greatly from year to year, sometimes destroying a very large percentage of the fruit, while in others the loss is very light.

THE WESTERN GRAPE LEAF-HOPPER, *Typhlocyba comes*, var. colorado Gill.

This western form of the grape leaf-hopper, which should probably be given the rank of a species, is common on the wild grapes growing in the mountains, but attracts attention chiefly on account of its iujuries to the foliage of the Virginia creeper. The injuries are more or less severe every year and it frequently kills the leaves almost completely by the first week in August.

THE WESTERN ROSE SNOUT-BEETLE, *Rhynchites Wickhami* Ckll.

This beetle is a real pest to roses in eastern Colorado, because of the pernicious habit of the adult of eating small holes in the rose buds. This beetle is readily distinguished from the eastern *bicolor*, having a black head. The writers have never taken one in the State. It is a native of the mountains where is it common to find the wild rose buds riddled by its punctures.

THE ONION MAGGOT, *Pegomyia ceparum* Bouche.

During the past few years this maggot has become a rather common pest in northern Colorado. In truck gardens it frequently destroys a considerable percentage of the crop.

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THE RADISH MAGGOT, *Pegomyia brassicae* Bouche.

What we have taken to be this species has, for several years, been a common radish pest, but we have never known it to attack cabbages. Turnips are often attacked by what seems to be the same maggot, but not as freely as the radishes.

EIGHT-SPOTTED FORESTER, *Alypia octo-maculata* Fabr.

This is a very common pest upon grape vines and the Virginia creeper, and is doing its principal damage in this State to the foliage of the latter vine, which is much used for ornamental purposes.

GREENHOUSE LEAF-TYER, *Phlyctoenia ferrugalis* Hon.

The greenhouse leaf-tyer, often called the celery leaf-tyer, has done serious damage in a number of greenhouses of the State. It has not been reported as numerous on any crops in the open, although in the East it has often been serious on celery. In the greenhouses it has attacked a large variety of plants, but has been most injurious to the chrysanthemums. The loss has not been wholly the physical injury to the plant by the eating of holes, by any means, but many beautiful plants have been made unsalable by the apearance of the foliage. The latter has undoubtedly been the most important loss for, as a rule, houses do not become seriously infested until the crop is almost ready for the market.

While the florists have different methods for its control, none seem to be very satisfactory. Some definite control studies should be undertaken.

COTTONWOOD LEAF-BEETLE, *Lina scripta* Fabr.

The cottonwood leaf-beetle is quite general on cottonwoods, poplars and willows of the State, but rarely does serious damage. At times, it has done considerable damage to poplars and cottonwoods in the nurseries of the State. A block of cottonwoods in one nursery was largely defoliated this past season. Good control is secured when arsenate of lead is applied.

SEED-CORN MAGGOT, *Pegomyia fusciceps* Zett.

In certain places late-planted beans were quite seriously injured by a maggot in the stems of the young plants. Some of this material was bred out by Mr. J. L. Hoerner and found to be the seed-corn maggot. Counts were made on some beans in the College garden, and also in a field southeast of Fort Collins, on July 6th, which indicated that the percentage of

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the young plants destroyed varied from 25 to as high as 50 in different parts of the fields.

THE COTTONWOOD SCALE, *Chionaspis ortholobis* Comstock

This scale is quite common on poplars, willows, cottonwoods and occasionally is taken on the aspen and honey locust. While it is not as serious a pest as many scale insects, it often does considerable injury to young trees or those that are low in vitality. It attacks principally the trunk and large branches and seems to thrive best on trees that are being grown under crowded conditions. Especially is this true in the nurseries.

OYSTER-SHELL SCALE, *Lepidosaphes ulmi* Linn.

The oyster-shell scale is quite abundant in many sections of the State, but is especially bad in the cities of Denver and Fort Collins. Serious damage is being done to ash trees and certain lilacs. In Denver, they are frequently found on willows, poplars and elm. The white lilacs seem to be practically immune from this insect, while others are very seriously attacked. It would appear that there are different varieties of this insect. In many states it is a serious pest on the apple trees, but in Colorado it has never been reported on this host. Apple trees growing under some very heavily infested ash trees in a small park of Fort Collins do not show any infestation.

THE PEACH BORER, *Sanninoidea exitiosa* Say

The peach borer is common in all sections of the State where stone fruits are grown. Although it has never proved as serious as reported in many southern and eastern sections, it often demands some attention of the fruit growers. More reports of damage have been received during the past season or two than usual, indicating that it may be on the increase. It has never been numerous enough to call for a systematic treatment of all trees, but is usually held in check by the fruit grower when at his other work by digging the larvae from the trees when they show infestation.

COTTONY MAPLE SCALE, *Pulvinaria vitis* Linn.

The cottony maple scale is an example of an insect that develops to a point of being a serious pest in cycles. It is general over most of the State but only occasionally does serious damage in any one locality. At these times, it may even kill trees. For three or four years it was very injurious in the City of Denver, but during the past year it has apparently been on the decrease, as very little damage has resulted even

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where control work has not been done. On the other hand, it has been abundant in the City of Colorado Springs. If it continues to increase, some steps will have to be taken at once to save many of the maple trees. It is proving the most injurious on the maples, but is often found quite numerous on box elders, locust, mulberry, grape vines and Virginia creepers.

Oil sprays applied during the dormant season are giving good control. Miscible oils, one part to 15 parts of water, and kerosene emulsion, 17 percent kerosene, are the most generally used. Those doing most of this work in the cities are of the opinion that the latter is not only cheaper but more effective.

THE BRONZE BIRCH BORER, *Agrilus anxius* Gory.

This is a serious pest on the white birch and its cut-leaved weeping variety in Colorado Springs, and has destroyed many beautiful and highly prized specimens. It has not been taken in any other localities.

THE EUROPEAN ELM SCALE, *Gossyparia spuria* Modeer.

Circular No. 29, treating of the life history and methods of control of the European Elm Scale, was issued during the past year to have this information available for the many inquiries that come in in regard to this pest. Its rapid spread in the city of Denver and its serious injury to the elms, their most important shade tree, make this a serious problem and one that will probably call for a solution by the city administration, as it will be difficult, if not almost impossible, to get the many thousand property owners to do the necessary work properly. Good results are being obtained with the use of miscible oils during the dormant season. They can be held in check by thoroughly washing the trees with a strong stream of water.

PEACH TWIG-BORER, *Anarsia lineatella* Zell.

The greatest damage done by this insect is by the larvae eating into the fruit. While at times they feed a great deal in the new growth of wood and kill back many new shoots, this rarely is of much importance except on young trees. They winter as partly grown larvae in small silken cells in the bark of limb crotches, coming out in the spring as the buds are swelling, when they eat into the buds and the new shoots. Another generation of larvae appears before the early and medium fruit ripens. Practically all of these feed upon the fruit, making many wormy and waxy fruits. They work to some extent on the plums and prunes as well as the peach.

The control method generally practiced is to spray early in the spring, before the larvae leave their winter quarters,

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with lime-sulphur, dormant strength, which kills the larvae in their winter cells; or with arsenate of lead to poison them as they eat into the buds or new growth. Some growers think best results are obtained by using the arsenate of lead in the lime-sulphur spray.

CUTWORMS

The native species of *Chorizagrotis,* viz., *chorizagrotis egrestis* and *auxilaris,* are usually the most abundant cutworms in most parts of the State. We have not had an opportunity to give the cutworm situation much special attention during the past season, but from what observations have been made and reports received, we have no knowledge of any serious cutworm outbreaks.

The varigated cutworm, *Peridroma saucia* Hubner, which was reported in the Eleventh Annual Report as being rather injurious in a number of sections of the State, has not been numerous enough this year to attract attention.

Climbing cutworms, the species of which have not been definitely determined, often do considerable damage in some of the peach orchards of the State. The fruit crop on a number of trees, especially those growing along ditch banks or in uncultivated orchards, is often greatly reduced by cutworms eating the buds early in the spring. Usually most damage is done just before the blooming period. Mr. Wm. P. Yetter collected in the Palisade section a considerable number of these larvae, but, due to heavy parasitism, no moths were reared for determination. Poison bran-mash has given good control. A climbing cutworm has at different times done considerable damage to carnations in greenhouses in the vicinity of Denver by eating holes into buds.

Due to the sudden importance of the Pale Western Cutworm, *Porosagrotis orthogonia* Morr., in Montana and parts of Canada, some concern has been felt as to whether it might suddenly become a serious pest in Colorado. That it has existed in the State for a long time is indicated by the following data taken from material in the Colorado Agricultural College collection:

No. 2332 collected, Fort Collins, 9-30-96 at light trap, C. P. Gillette.
No. 2336 collected, Fort Collins, 10-5-96 at light trap, C. P. Gillette.
No. 2337 collected, Fort Collins, 10-5-96 at light trap, C. P. Gillette.
No. 2751 collected, Fort Collins, 8-30-97 at light trap, E. G. Titus.
No. 2758 collected, Fort Collins, 8-2-97 at light trap, E. G. Titus.
No. 2763 collected, Fort Collins, 9-4-97 at light trap, E. G. Titus.
No. 2790 collected, Fort Collins, 9-27-97 at light trap, E. G. Titus.

S. Arthur Johnson has recorded in unpublished notes that this species was numerous enough at Loveland and Longmont during 1911 to do considerable damage.

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During the past season Mr. J. L. Hoerner has operated a light trap on the College Campus. His records show the following catch of *P. orthogonia* moths:

August 6..... 1	Sept. 15.....23	Sept. 20.....81
August 28..... 1	Sept. 16.....40	Sept. 21.....53
Sept. 2..... 3	Sept. 17.....55	Sept. 22.....28
Sept. 8..... 2	Sept. 18.....54	Sept. 23.....24
Sept. 14.....22	Sept. 19.....39	Sept. 24..... 4

It is rather strange that the moths should appear so late in the season, August 2d being the earliest record of the moth being taken, with the maximum catch at the light during the season of 1920, on September 20th. This apparently is later than they appear in Montana. Mr. J. R. Parker, Bozeman, Montana, writes "We found them here in greatest numbers from August 26 to Sept. 1, in 1919, and from August 19th to August 23d, in 1920."

THE MEXICAN BEAN-BEETLE, *Epilachna corrupta* Muls.

The Mexican bean-beetle, or "bean beetle", as it is called, continues to be a very serious pest upon all garden and field beans in the foothills section east of the mountain range, and in the southern part of the State. It has not appeared in any new sections so far as we know. The eastern border of the infestation continues to be Greeley, in the northern part of the State, and Rocky Ford in the south central part. It is strange that the infestation has not extended into the Delta County section, and farther into the irrigated portion of the Arkansas Valley.

Life-history studies and studies of control methods have been carried on the past three seasons, through co-operation with the Agricultural Experiment Station. It is hoped that this data can be published in the form of an Experiment Station bulletin this coming spring.

While the general opinion has been that control methods were of little value, this work indicates that a careful use of arsenite of zinc, and possibly also arsenate of lead, will give quite satisfactory results.

The discovery of this pest in the State of Alabama and its serious injury to the crops of that section, has been one of the entomological features of the past year, and is causing the southern states more concern than most any other insect pest.

SAN JOSE SCALE, *Aspidiotus perniciosus* Comst.

The infestation of this scale in Mesa County has been the only infestation known to exist within the State until late this fall, when Mr. J. H. Newton located an infestation on Bone

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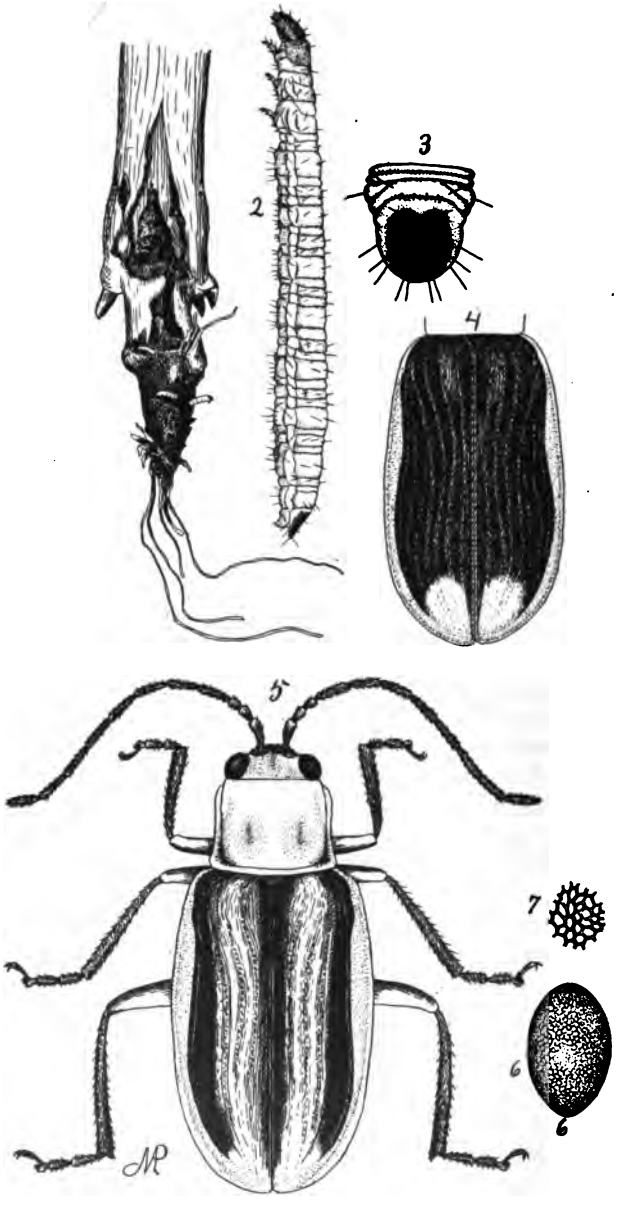

Plate III. *Diabrotica virgifera* Lec. 1, Corn root attached by the larvae, 2/3 natural size; 2, larva; 3, dorsal view of last segment of larva; 4. dorsal view of elytra of male; 5, female; 6, egg; 7, reticulation of egg shell. Figures 2, 4 and 5 are enlarged 10 diameters; figure 3, 16; figure 6, 30; and figure 7, 80 diameters. Original in Jour. Ec. Entomology, 1912, p. 365. M. A. Palmer, Delineator.

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Mesa near Paonia, Delta County. At present it is thought that this is confined to a very limited territory, and it is hoped that the infestation can be exterminated.

In Mesa County, the infestation has continued to spread. At the present time, there is some scale in practically all sections of the county. However, it has done serious damage only in certain orchards that have been more or less neglected.

During the past spring, Mr. L. E. Jaynes, County Horticultural and Pest Inspector of Mesa County, put on a very thorough campaign for the control of this pest, with the result that all known infested orchards received a thorough dormant spraying. While some scale was found in some of these orchards later in the season, the infestation was not serious enough to cause a material loss.

COLORADO CORN ROOT-WORM, *Diabrotica virgifera* Lec.

C. P. GILLETTE

The writer first called attention to this insect as a corn pest in 1912*. Since that date, occasional inquiries have been received concerning it and they are becoming more and more frequent. Apparently, the beetle is quite generally distributed over the plains area in the State east of the mountains where corn is rather extensively grown. It is quite common in the Fort Collins section which, apparently, marks about the northern limit of its range, while it is known to occur much farther south. In gardens or in fields, where corn is planted after corn for two or more years, it often becomes very destructive, stunting the growth of the corn and destroying so much of the roots and crown that the stalks readily fall in a wind. Apparently, this injury is often called "root-rot" by the farmers. The trouble can be completely avoided by being careful not to plant corn on the same ground two or more years in succession.

CODLING MOTH, *Carpocapsa pomonella* Linn.

GEO. M. LIST

The codling moth continues to be by far the most important insect pest of the apple and pear crops of the State. During the past year it has taken probably a larger percentage of the apples and pears than in any season in the history of the State. Complaints have come from all sections of difficulty in securing satisfactory control and unusually heavy infestation. The season has been warm, and in most sections, very dry, which has made conditions apparently very favorable for the

*Journal of Economic Entomology. Vol. 5, page 364.

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development of the pest. The great variety of conditions that exist in the different mountain valleys of the State, where most of the fruit growing is carried on, makes it very difficult to give general recommendations for the control of this pest, and even the season in any particular valley varies to such an extent that it appears that definite recommendations in regard to spray schedules can be made only after some quite careful studies on the life history of the insect have been carried on each season. In some sections there is only one brood with a partial second, while in others we have two complete broods, and in still others, a partial third brood. Studies indicate that in certain sections they are much more prolific than in others and with much lower winter mortality. These conditions call for a variety of spray schedules, ranging all the way from three applications to as high as seven or eight.

The most difficult situation exists in the Grand Valley, Mesa County. It has been estimated that the loss to the apple and pear growers during the past year in this one section has been fully three-quarters of a million of dollars. The damage was so great that very few extra fancy apples were shipped from the Valley, and in many orchards the crops did little more than to pay for the expense of growing. While the growers can be criticized in regard to many of their orchard practices in connection with the codling-moth control, it is believed that this heavy loss has not been entirely due to their lax methods. After investigating the spraying practices in many fruit-growing sections of both the East and West, it is believed that the growers in this particular section are, as a general thing, more thorough in their spraying work than any other section visited, but, during the past season, even the most thorough growers, who have in the past secured crops which were reasonably free from codling-moth injury, have had very heavy losses.

While considerable work has been done in past years in connection with the solution of this problem in this immediate section, nothing has been done the past season. Possibly one reason for the poor successes has been the lack of expert advice in laying out the spray schedule. It is hoped that another season an entomologist can be placed in the field to keep the growers posted, and also to encourage them in doing the most thorough work possible.

In some localities, there are neglected orchards that have made the problem more serious. Meetings have been held with the fruit growers to discuss the solution of these problems. The formation of pest districts in which the owners of neglected orchards can be compelled to give them proper attention or remove the trees, has been thoroughly discussed and

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it is probable that a large portion of the fruit-growing section will be thrown into pest districts for next year's codling-moth control.

At a meeting held in Grand Junction for the discussion of the coming campaign, the following paper was read by the writer for the opening of the discussion:

TO THE FRUIT GROWERS OF MESA COUNTY:

The codling moth presents one of the most serious situations that has ever confronted the Grand Valley. It has been steadily growing worse until the loss this season has represented a large percent of the apple crop and a considerable percent of the pear crop. The loss has probably been over three-quarters of a million dollars. Entire orchards with a good crop have operated at a loss. The section cannot long endure this loss and continue to be a fruit-growing section of prominence. The loss has not been confined to the fruit made unsalable by the pest, but the reputation of the section has seriously suffered. It is common talk on the markets and among the buyers that go to the fruit sections that Grand Valley fruit is not dependable on account of the codling-moth injury. While they like its size and color, it must be bought, if bought at all, at a big margin. While it may not sound good and many will not let themselves believe it on that account, the future of the Grand Valley as an apple and pear section is far from being bright. There is no section that can stand a loss of from 20 to 100 percent of its fruit, and to a large extent its reputation, and successfully compete with other more-favored sections.

I need not tell you that this industry is probably the most important one of the Valley. It cannot be lost without being a serious setback to all interests. Owing to the character of the soil and other conditions, the system of farming cannot be greatly changed without bringing about a great loss in land values, income and number of families that can make their homes in the Valley. This will be a serious thing for individuals making the Valley their home, and it cannot help affecting the business and financial interests.

So it is a problem common to all. These remarks are not made in the role of a prophet, but with the hope that they will help to bring all concerned to realize the conditions that exist and bring about such co-operation as will tend to improve conditions. The office of the State Entomologist and the Colorado Agricultural Experiment Station, in co-operation with the Bureau of Entomology, U. S. Department of Agriculture, have done considerable work during the past few years on the life habits and control of the codling moth in the Grand Valley. It is hoped that at least two bulletins on this work can be published this winter, probably by the Department of Agriculture. It is believed these results will be of great help to the growers. However, the work has not brought out any new and easy method of successful control, but has, if anything, emphasized the importance of careful and hard work at the proper time. These studies have shown up many weak points in the organization and work that have a very direct bearing upon results. Some of these are brought to your attention now as they cannot all be well brought out in the report of these studies, and because it is important that all growers be thinking and working on some of them at once.

IMPORTANCE OF PRUNING

Codling-moth control is the most important limiting factor in successful fruit production in Mesa County, so all practices should be ad-

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justed to fit the conditions. There are many theories and practices in pruning work that are important, but none are so rigid but what they can be varied if necessary to make codling-moth control more effective. Every pruner, before starting on a tree, should ask himself What can I do to make codling-moth control more effective?—and then do it. The grower can afford to sacrifice some fruiting wood in order to be able to protect the fruit on the remainder of the tree from pests. The trees should have doors on at least three or four sides thru which the sprayer can get to the center of the tree to spray the tree from these positions. Each limb should be so spaced that it can be sprayed from all sides and the fruit spurs thinned so that there will be no doubt as to the possibility of doing thorough work. At least 75 percent of the orchards in the Valley are not so pruned that the most effective spraying can be done. This is one of the most serious drawbacks to the codling-moth work and one that should surely be remedied at once.

CLEAN-UP WORK

Under the favorable conditions that exist for the development of the codling moth in the Valley, it is never going to be practical to depend on spraying alone to get the best results. While this will always remain the most effective method of fighting the pest, the fight must be made a year-around job and everything possible done to reduce the infestation. With the infestation that now exists in practically all the orchards, it will be almost a physical impossibility for most growers to grow a profitable crop of fruit next year. All of next year's codling moths will come from those that are wintering over in the orchards at this time.

Great help will come to next year's work if everything possible is done to reduce the number of over-wintering insects. It will be possible to reduce the present infestation as much as 40 to 75 percent by thorough clean-up work in the orchard and about the premises. The fruit growers who are making a success of controling the codling moth are, in practically all cases, those who kill the insect at every opportunity, and are not afraid to go to considerable extra labor to destroy even a few of the pests. The growers who fail to go over all of their trees and scrape off the rough bark and kill all of the over-wintering insects, are missing one of their best opportunities to control the pest and cannot expect satisfactory results next year.

Your County Horticultural Inspector has been asked to give all the time he can possibly spare to the work of encouraging growers to take up this line of attack. It is hoped that satisfactory results can be secured.

Some larvae are over-wintering in rubbish about the trees. It would be advisable to cultivate the orchards wherever this is possible and destroy as many of these hibernating places as possible. If the rough bark in which the insects are hibernating is scraped from the trees during the colder weather, practically all of the insects will be destroyed either by exposure or by the birds. The work should be very carefully done as a very few larvae left on your trees will mean a great many more to fight before the season is over next year. Miriads of the insects winter over in store houses and in old boxes about the premises. It is a paying proposition to go over all the old boxes and destroy all the larvae that can be found and all store houses and packing houses should be screened wherever this is at all practical. Whenever the growers of the Valley realize that this system of fighting the insect and also the use of bands during the summer is almost as essential as the spraying, much better results will be secured.

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REDUCTION OF ACREAGE

The Grand Valley should always continue to be a fruit-growing section, yet there is little doubt in the mind of anyone who has studied the conditions but that there should be a considerable reduction in the acreage that exists at the present time. For various reasons, which we need not mention in detail at this time, probably 30 percent of the acreage of apples that exists should be pulled out. These orchards are not being made profitable and it is very likely they never will, and are only a detriment to the growers attempting to make a living from the more desirable orchards. They not only reduce the standard of fruit put out by the Valley on account of the poor quality that they produce, but they are usually breeders of pests that do great injury to the grower that is otherwise in position to grow a profitable crop. Much of the ground occupied by such orchards could be made reasonably profitable in other crops and in the long run would be of more value to the entire community.

TENANTRY SYSTEM

The tenantry system of farming is proving a great drawback to many agricultural sections. If it is not working satisfactorily in the sections where general farming is being done, it is hardly reasonable to expect it to be satisfactory in a fruit-growing section where the successful growers must be specialists.

While it is not true in all cases, it is quite generally true that many orchards are for rent because they have proved unprofitable to the owner. It is also true that most tenants, even with good orchards, are not making a success of the fruit-growing industry. The successful growers are those who plan their work years ahead and even know the individual trees in their orchard as a stockmen would know the individual animals in his herd. The tenant is usually working on a yearly basis and cannot, even if he is inclined to do so, do the necessary work to keep the orchard in prime condition. It will take a series of years of very careful and thorough work to reduce the codling-moth infestation in many of the badly infested orchards. If these orchards are to be rented, they should be rented on a basis whereby the tenant can afford to do the necessary clean-up work and be required by the lease to do so, and get the profits that will result from this work at the end of the second or third year. If the non-producing land-owner does not care to make such arrangements or cannot find a reliable renter for a series of years, it would be better for the community to have the orchard removed at once.

LACK OF MACHINES

It is a physical impossibility to successfully control the codling moth with the equipment that is in the Valley at the present time. Many growers have lost enough fruit during the past season to have more than paid for good equipment and I believe this is the case practically every year. Too many orchardists have been depending upon their neighbors for their spraying work. While it is realized that the small owners cannot all afford to have a machine, there should be enough machines on hand to spray the entire acreage of orchards within five to eight days. Under the present conditions it is nothing uncommon to hear of spraying machines that spray practically every day from the beginning of the season until almost harvest time. This means that many have not had their spray application made at a time that will give them protection. It is doubtful if one ordinary machine can take care of more than twenty acres of bearing orchard, so any orchardist that engages a machine and does not have a very definite understanding as to the amount of work this machine is to do and just when he can secure it, is probably throwing away his fruit crop by such an arrangement.

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The system of custom spraying has been a very serious drawback to successful codling-moth control. Each individual should make every effort possible to have a complete equipment of his own. If this is not possible, there is no reason why a limited number of small growers could not have their own equipment and confine its work to their own acreage. Many of the difficult problems in agricultural work will very likely be solved only by community co-operation. In a section that is depending entirely upon fruit, it would seem only a wise thing for the community thru some system of co-operation, to supply machines enough to do adequate work. The more fortunate growers could no doubt well afford to assist their less fortunate neighbors in securing the proper equipment or credit for equipment. If the financial interests and the commercial men of the section wish to do something to better the conditions of the entire county, they can do nothing better than to assist the fruit-growing sections in getting the necessary financial aid to secure the proper equipment. The cities should realize that they are more dependent upon the country than the country is upon the city and should do everything possible to assist in the solution of these serious problems.

SYSTEM OF CHARGING FOR CUSTOM SPRAYING

While it is realized that custom spraying will always be a necessity in a section having such small orchards as exist in the Grand Valley, it should be done away with as much as possible and so organized that the best results will be obtained. The system of charging for the custom spraying that is in vogue at the present time has probably been a greater drawback to effective work than the custom spraying itself. Piecework, even in factories, where the closest supervision is possible, has not been entirely satisfactory, and spraying by the tank in the orchard section has been responsible for more careless work and responsible for the breaking down of more sound spraying practices than any other one thing. The ambition to spray out large numbers of tanks has overcome the better judgment of practically all custom sprayers and has even influenced a large percent of those who hire the custom machines.

No one in particular has been to blame for this. It is only human nature that anyone would make all the money possible out of his work and the condition has grown upon the entire section little by little. The custom sprayer, who does good work, is entitled to good wages and considerable for the wear and tear on his machinery, but in his ambition to spray out large numbers of tanks, he should not forget the interests of his employer. It is doubtful if any ordinary equipment can satisfactorily put on more than ten 200-gallon tanks of spray in one day. Yet, it is not uncommon to hear of many machines putting on from fifteen to twenty-five. This usually means that much material has been wasted and poor work has been done. The results are best shown at harvest time. A large part of this difficulty could be overcome if all of the small growers who must depend upon hired machines for their work would hire them only by the hour and pay them for their actual running time. This could well be more per hour than is being paid for the machines at the present time and still the employer be the gainer.

It is common talk among many custom sprayers that they have one set of nozzles for their own spraying work and another set for their neighbors. You know the reason. Even where there is only a small acreage concerned, the owner certainly could afford to have his own equipment of rods and nozzles that he could use for his own orchard only and depend upon the custom sprayer for only the power. In this way he could get his spray adjusted so thorough work could be done and when he started to work on his next application, the same character of spray would be available and uniform work could be done. I believe that if

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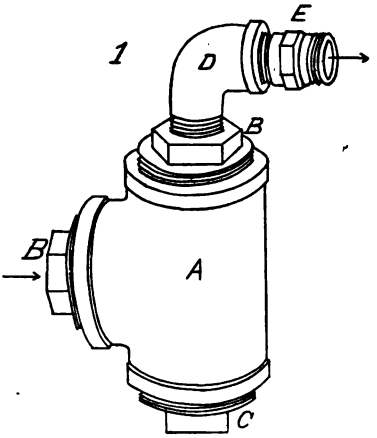
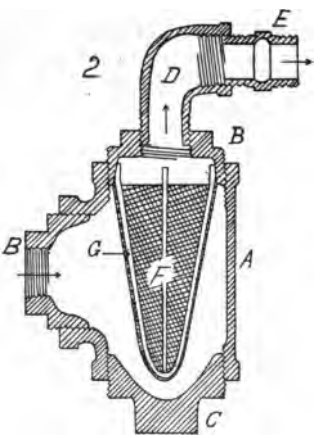
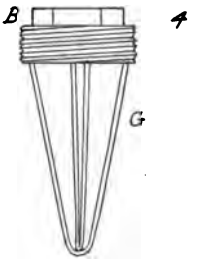




A - 2 in Galvanized Tee
B - 2 x ¾ in Bushing
C - 2 in Plug
D - ¾ in Galvanized Street Ell
E - ¾ in Hose Nipple
F - Screen Cone
G - No. 14 Galvanized Wire



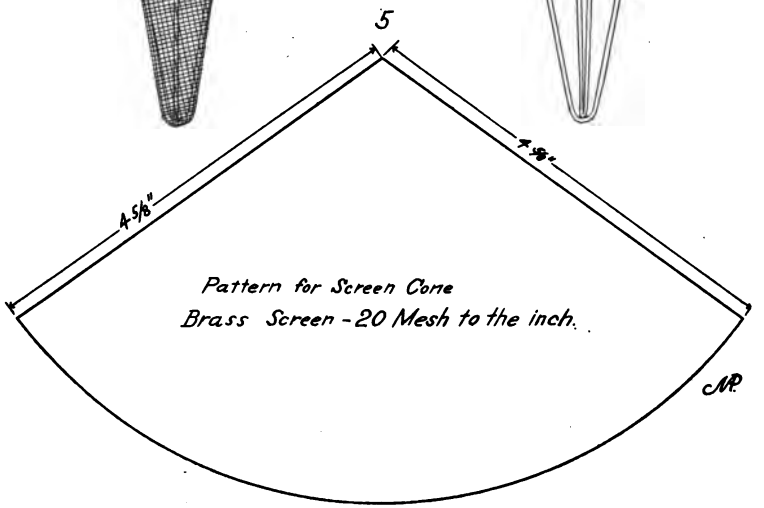


Plate IV. A Practical Spray Strainer. Prevents clogging of nozzles by rust, scale and other foreign materials in liquid. Easily cleaned by removing plug C. Most heavy particles drop from screen when pressure is removed. Strainer should be attached in pressure line between cut-off and hose. Liquid is forced under pressure, into tee through side bushing and upward through screen, as indicated by arrows. The arch formed by the No. 14 wire prevents screen from collapsing. Adapted with modifications from U. S. Bureau of Entomology, Salt Lake City Station. Successfully used by this Office at Paonia, Colorado.

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all orchardists would practise this system and hire their machines only by the hour, and insist upon careful work being done, that the efficiency in controlling the pest in their orchards could be increased from 10 to 40 percent.

COMPULSORY CONTROL WORK

Effective compulsory control against the codling moth is more difficult to handle than against most any other insect pest. Successful control under the conditions that exist does not depend upon performing any one operation at a specified time but rather upon the careful performance of a number of operations at times that cannot always be established far in advance and upon the performance of these within a limited time. This makes the problem of supervising the work and enforcing regulations very complex. In the enforcement of pest districts which have been formed or may be formed, it is doubtful if it will ever be practical for the county, thru the county inspector, to re-spray orchards that have not been properly sprayed, or to spray those where the work has not been done at all. On account of the large acreage, it can be readily seen that the county would necessarily need a large corps of men and a considerable number of spray machines at their command. Even then, it would be difficult to do the work at the time the best results could be obtained.

The inspection laws provide for a fine where instructions have not been properly carried out. This clause might be employed to advantage in some cases, but it is evident that it could not be used until there was a failure to do the work and then the insects would not be destroyed for the protection of the innocent neighbor. Many have suggested that where proper work has not been done that the trees should be cut down. This is action that should be carefully considered before being carried out on a large scale.

It is possible to give the owner, in case he has failed to do the work, or to do it in a thorough manner, an option of either picking all of the fruit from the trees and destroying it before the codling moth bred from it can do injury to his neighbor, or to have his trees cut down and thus destroy the fruit. Even this is very drastic action, and in order to be made effective, would need the moral support of the entire community, as well as the moral and financial support of the Board of County Commissioners. Yet it is going to take drastic action to control the pest and bring the reputation of the section back to what it should be. It is something that would very likely work an injustice upon some individuals and a movement that others might endeavor to take advantage of on account of personal reasons. All within the area should realize that it is something that could be used against them as individuals. It is often the case that many who are the loudest in advocating such action are those that should have the same action on their own orchards. It would take a well-organized force to enforce such regulations uniformly. It would not be possible for one inspector to handle any large territory. For the entire Valley, a number would be required.

Pest districts should not be hastily formed for codling-moth control. A thorough understanding among the orchardists as to just what would be required in the enforcement of the law is quite necessary for success, as is the co-operation between the growers and County Commissioners.

In the Delta County fruit-growing section, the conditions are not as serious as in Mesa County. Usually a three-, four- or a five-spray schedule, depending upon the degree of infestation and the variety, will give satisfactory results. While some growers in this particular section have been dissatisfied

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with the past year's results, as a general thing they have been far better than obtained in the Grand Valley. The greatest fault with the sprayers here is a lack of thoroughness and a lack of attention to the proper time for the application.

During the past year, Mr. J. H. Newton, assisted by Mrs. A. J. Cady, has carried on very complete codling moth life-history studies at Paonia. This completes the fourth year's study of this insect in that section, and these studies have brought out some very important facts. They have enabled the establishment of spraying schedules that are giving far better results than obtained before. These studies over a four-year period bring out the importance of making seasonal studies each year in the important fruit-growing sections. If spraying applications are to be made at the optimum time, this can be determined only by careful studies during that season. For instance, in 1917, the first eggs of the second generation were deposited July 25th, while in 1919 the first eggs appeared July 5th, just twenty days earlier. Taking the development of the insect from egg to egg as a complete life cycle, the average time for this in 1918 was 61.29 days; 1919, 48.11 days; 1920, 54.89 days, showing a maximum difference of 13.18 days between the seasons of 1918 and 1919. With a difference of practically two weeks in the length of the life cycle in the different seasons, it can readily be seen that spray schedules fixed by rule cannot be the most effective.

During the past season, the Lund orchard at Paonia, which is one of the oldest orchards of the State, and considered one of the wormiest in the Delta County section, has been sprayed as an experimental orchard. The three-, four- and five-spray schedules were tested. The results of this work, in connection with certain phases of the life-history studies that will enable the growers to better determine their spraying practices, will be published in an Experiment Station bulletin in the very near future.

Mr. Wm. P. Yetter, Jr., has carried on life-history studies of the codling moth at Canon City, Fremont County. These are the most thorough studies that have been carried on in this section. They indicate that the conditions are very similar to those at Paonia. There was one complete generation and something less than 50 percent passed through a second generation. At Paonia, the percentage of the insect going through a second generation has varied from 20 to 40, according to our data.

FRUIT-TREE LEAF-ROLLER, *Archips argyrospila* Walker.

GEO. M. LIST

The fruit-tree leaf-roller is known to exist in all fruit-

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growing sections of the State, except Mesa County, where it has never been taken to our knowledge. It is also quite common upon many shade trees. It has been serious enough in the city of Denver to cause considerable injury to elm, maple and ash trees. It has not been serious enough to justify remedial measures in any fruit-growing section but Fremont County during the past year. Here it has been unusually bad over a period of ten years, and has almost made fruit growing in this particular section unprofitable. While it is felt that the use of arsenical sprays will give some protection against this pest, they have not been uniformly satisfactory to the growers, hence, their use has been almost discontinued and the growers are depending entirely upon the use of miscible oils applied during the dormant season.

The fruit-tree leaf-roller infestation was unusually serious during the year 1918. That fall, the fruit growers organized pest districts in which control work would be required of all orchard owners. This was given a thorough trial during 1919, with the result that the infestation was materially decreased. These districts have been enforced during the past year as well as conditions would permit. Mr. D. S. Moore, the County Horticultural and Pest Inspector, has worked hard in getting the entire section sprayed and in inducing the orchardists to do as thorough work as possible.

Mr. Wm. P. Yetter, Jr., was also in the section and gave considerable time to the work. They were very much handicapped during the spring season by windy weather and lack of proper equipment and, later, by a shortage of the miscible oil that was being used in the campaign. However, all of the orchards, with but one or two exceptions, were sprayed. In case the owners refused or failed to do the work, it was done by the county through the county inspector.

In the S. S. Courtney orchard, which was sprayed by Mr. D. S. Moore, County Inspector, check trees were kept. It was estimated that from 50 to 75 percent of the foliage surface had been destroyed on these check trees, and not over 5 percent on those trees that had been sprayed. This work was done on a day when spraying conditions were good and it was felt the work was thoroughly done. Eggs were collected from the check trees and also from the trees that had been sprayed. An effort was made to collect these from all parts of the trees so as to have representative samples of those that had been sprayed. Of the eggs used as checks, 2,551 hatched; 887 failed to hatch. Of those taken from trees that had been sprayed, one hatched and 3,360 failed to hatch. During June, Mr. Yetter carefully counted the infested fruit spurs on portions of three sprayed and three unsprayed trees, and

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then estimated the total percentage of infested fruit spurs on the entire tree. The three unsprayed trees showed an average fruit-spur infestation of 92.21 percent, while the three sprayed trees showed an average fruit-spur infestation of 9.45 percent. On the unsprayed trees, practically the entire fruit crop was destroyed by the fruit-tree leaf-roller larvae when in the bud and blossom stage. Practically no fruit set on the trees, while the sprayed trees carried a fair crop of fruit. In this work, Target Brand miscible oil was used, one part to 15 parts of water.

Some observations made in the season of 1918 and reported in the Eleventh Annual Report of the State Entomologist, indicated that moisture, either in the form of rain or snow coming upon the trees within one, two or even three days after the application of miscible oil had been made, greatly reduced the efficiency of this material in controlling the fruit-tree leaf-roller. This last spring, a number of masses of eggs were treated in the laboratory with Target Brand oil, one part to 171/2 parts of water, and later, at different times, sprayed with a fine mist of water to determine the effect of this treatment upon the effectiveness of the material, with the following results:

Sample No. 1—Sprinkled for one-half hour two hours after treatment with a fine mist of water: 27 egg masses; hatched 29 eggs, not hatched 1,483 Of the eggs that hatched 26 were in one mass.

Sample No. 2—Sprinkled for one-half hour 25 hours after treatment, 28 egg masses; eggs hatched, 1; not hatched 1,681.

Sample No. 3—Sprinkled for one-half hour, 48 hours after treatment, 22 egg masses. Eggs hatched, 2; not hatched, 1,242.

Sample No. 4—Sprinkled 73 hours after treatment for one-half hour, 28 egg masses. Eggs hatched, 1; not hatched. 1,596.

Check: 25 egg masses, eggs hatched, 968; not hatched, 424.

This would seem to indicate that possibly the effect of moisture upon the effectiveness of a miscible oil in leaf-roller egg destruction has been over-estimated, and that the failures to get results that have been attributed to rain or snow possibly have been due to some other condition.

A SUNFLOWER PEST

J. H. NEWTON

In Delta and Montrose Counties, during the season of 1920, sunflowers grown for ensilage were, in several cases, heavily attacked by small coleopterous larvae. Successful rearing of the pest has not been accomplished to date, but a small snout beetle, found abundant on the infested plants, is probably the adult. It remains for later rearing to determine whether or not this supposition is correct. It is believed that the insect is native to the district because the wild sun-

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flowers are found infested by it over the two counties mentioned.

No attempt was made to estimate the damage in the commercial fields, but some of the damage investigated indicates that it may become a serious menace to future sunflower production.

The larvae may be found boring thru all portions of the stalk, but chiefly thru the fibro-vascular bundles of the outer, woody portion, producing a girdling effect upon the plant. The stalk turns to a dark brown color, the leaves shrivel, and the seeds fail to mature.

Two rows of sunflowers containing approximately one hundred and fifty plants were so badly infested that none matured. A visit to some of the commercial fields near Eckert, just after cutting time, showed that there had been considerable damage, but it was too late to make an estimate of the loss.

COTTONWOOD CROWN BORER, *Bembecia tibialis* Harris

J. H. NEWTON

The writer has watched with interest for two years the work of a certain borer upon the poplar trees in the city of Paonia. Further observation proved it to be the larva of a clear-winged moth (*Bembecia tibialis*)*. It is a pernicious borer working in the cambium layer just beneath the bark at the base of the tree. Some individuals have been found boring on the larger root branches three feet from the tree base. The end is a complete girdling of the tree with the introduction of fungus rot and secondary insect pests. Many of the larger trees are waging a losing fight against the pest, while others, both young and old, have already been killed. The life cycle of the insect has not been worked out for Colorado, but the following notes may be of interest:

The larvae mature sometime during the latter part of July as the adults emerge from the cocoons about the 15th of August. The moths usually emerge in the early morning and can be found in copulation by the middle of the forenoon. The mature larvae construct elongate cocoons in the burrows under ground at the surface of the soil. The cocoon is composed of borings and fine chips cemented together, except for the anterior end, which is capped with a thin layer of silk only. The newly emerged moth gains freedom by breaking thru the silken cap.

The adult is a very pretty individual, marked with yellow and black bands. At first, the casual observer is liable to mistake it for one of our yellow-jackets or similarly colored wasps. Such an experience was afforded the writer in 1917 when one of the moths flew into the laboratory and was avoided because it appeared to be a wasp. Closer observation, however, proved it to be a clear-winged moth, but its relation to the

*Determined for us by A. Busck.

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poplar as a pest was not discovered until later. The females measure one inch in length; the males only three-fourths of an inch. The eggs are deposited on the tree trunk near or at the soil surface.

The only control measures tried so far have been the laborious task of digging out the larvae from around the tree. It may be that some of the methods used against the peach-tree borer would be effective in this

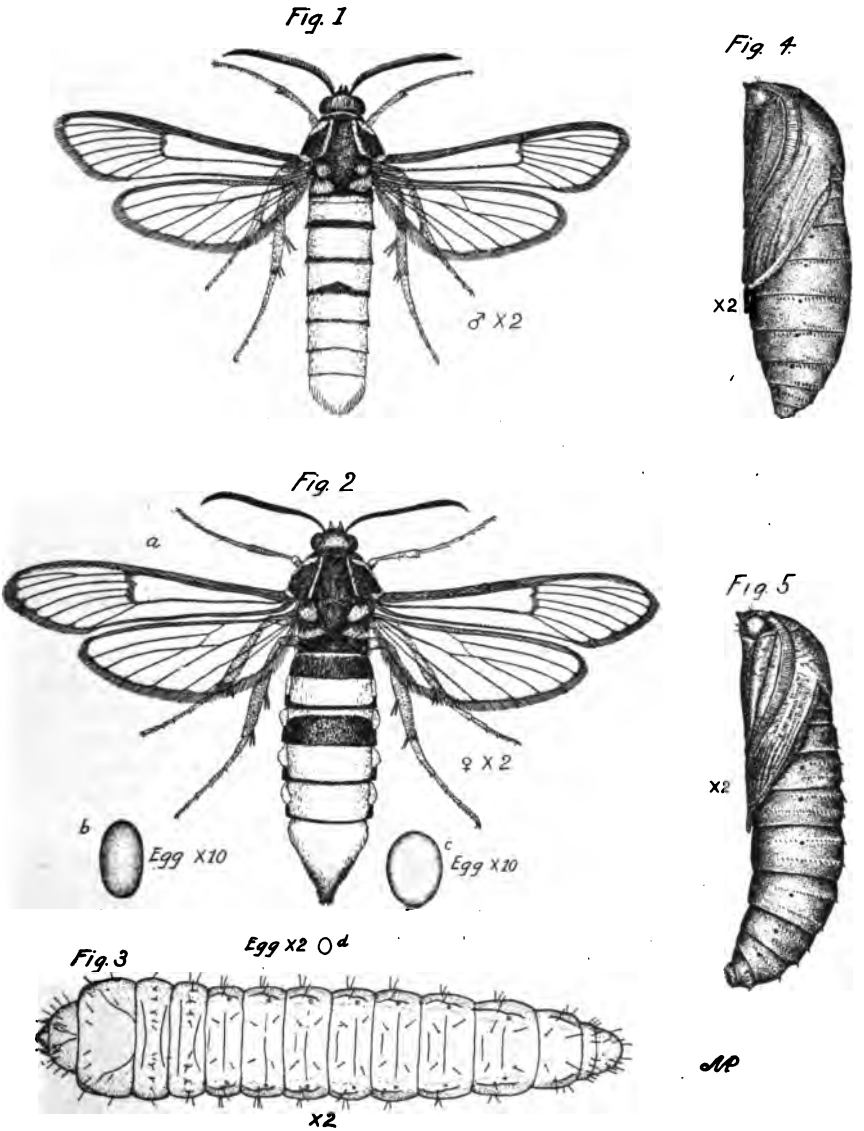

Plate V. The Cottonwood Crown Borer, *Bembecia tibialis* Harr. Figures 1 and 2, adult male and female; b and c, eggs; 3, larva; 4 and 5, chrysalids. Original, M. A. Palmer, Delineator.

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case but no recommendations can be made until tests have proved their value.

The writer and other members of the force working at Paonia had a very interesting experience with these moths on August 15, 1920. Previously a number of pupae had been gathered from infested trees and brought to the laboratory for rearing. About 9:00 o'clock on the aforementioned day, a female emerged from the collected material. The female was removed from the rearing cage, stupefied with chloroform and placed on an outside laboratory table for photographing. Before the camera had been satisfactorily focused, a male moth appeared on the scene, presumably attracted by the female. By careful manipulation the male was captured, but the feat was hardly completed before another male visitor appeared. The appearance of males continued until noon when eighteen males had been captured. Many of the males were so brave as to almost light upon a person holding the female in his hands. About 11:00 o'clock of the same morning, a visit was made to some nearby trees where six copulating pairs were easily captured.

ALFALFA WEEVIL, *Phytonomus posticus*, Gyll.

PROGRESS REPORT

J. H. NEWTON

During the season of 1920, work upon the alfalfa weevil in Colorado consisted principally of scouting from the known infested territories into adjacent, cultivated areas, to determine the spread of the weevil during the year previous. Public meetings were advertised and held to allow the people an opportunity to become familiar with the method of scouting, its results and the purpose of the quarantines that were maintained. Control experiments were conducted as in 1918 and 1919, but only to a limited extent, for the purpose of checking results before obtained.

The Ninth, Tenth and Eleventh Reports of the State Entomologist give a detailed account of the weevil in Colorado. The latter two describe and illustrate the life history of the insect as it occurs in the State. For description of spray results and sprayer attachment adapted to alfalfa-weevil control, see the Tenth Annual Report.

RESULTS OF SCOUT WORK FOR 1920

Scouting began June 6th and continued until the 21st. The outlying boundaries of the known infestation for 1920 were scouted first. In Delta County, presence of the weevil was reaffirmed at Eckert, Hart's Basin and Redlands Mesa. New infestations were located at Payne's Siding, Austin, and in several fields surrounding the City of Delta on the east, south and west. In accordance with the spread of 1918, during 1919 the weevil again spread six to seven miles beyond the outlying borders of the previous year's infestation. Considering the fact that the scout work, in all probability, does not detect the presence of the insect beyond the point where they occur in considerable numbers, and that the true borders

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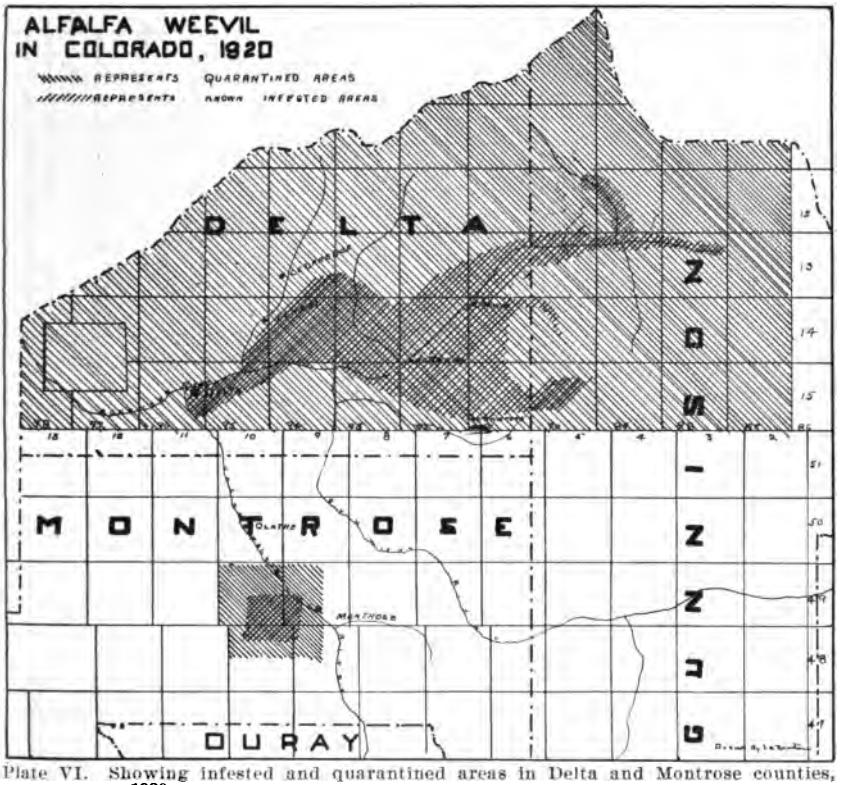

Plate VI. Showing infested and quarantined areas in Delta and Montrose counties, season 1920.

of infestation must occur a considerable distance beyond the point where positive results would be obtained, it would not be unreasonable to state that ninety percent of the alfalfa acreage in Delta County is now infested with the alfalfa weevil. The known infested area is charted on Plate VI.

In Montrose County, the infested area has spread from four square miles to twenty-five square miles, and is six times as great as in 1919. In this county, the spread has been somewhat uniform, except that the greatest spread has been to the south. By referring to Plate VI, it will be seen that the known areas of infestation in Delta and Montrose counties are separated by an uninfested strip only fifteen miles wide. It is only a question of time until this area will become infested. A scouting trip was made into the southern and eastern ends of Montrose County covering the territory around Norwood, Redvale, Naturita, Nucla and Paradox. Reports had been circulated that suspicious injury occurred in this dictrict, but no examples of the weevil were found.

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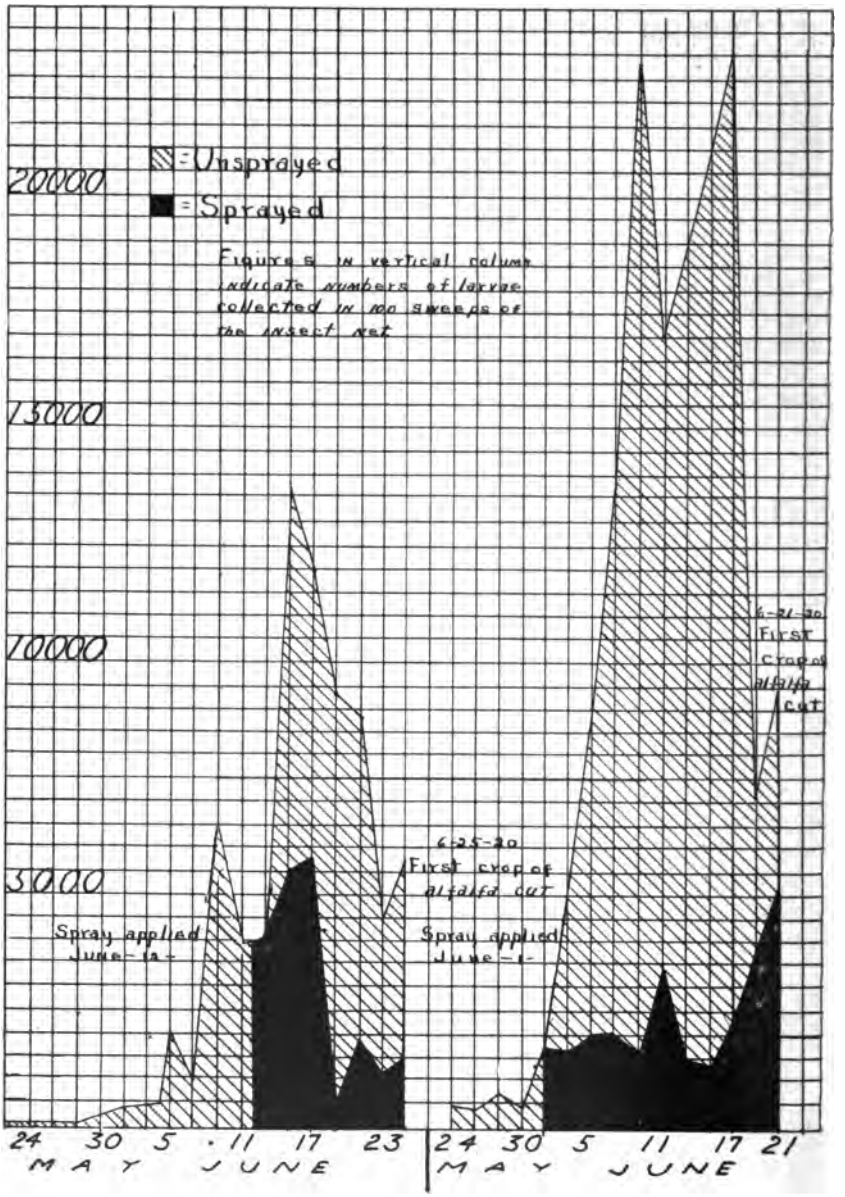

Plate VII. Crosshatched area represents the number of larvae collected in an unsprayed plot each second day throughout the growing period of first crop. Dark area represents the number of larvae after date of spraying in sprayed plot of same field. Note reduction in number of larvae due to spraying and also the difference in infestation between Plots 1 and 2.

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INJURY TO THE CROP IN 1920

A larger number of fields in the upper North Fork Valley needed to be sprayed for weevil control than ever before. Injury to the alfalfa was about normal, ranging from slight injury to sixty and seventy percent loss of the first crop, followed by a delay of the second crop where control methods were not applied.

The alfalfa weevil is not a pest that comes today and is gone tomorrow, but rather it is a new pest in a foreign land comparatively free from natural enemies and living under most favorable conditions for its existence. Farmers living within infested areas must sooner or later make preparations to fight the weevil. The time to make these preparations is not at the last minute, or after most of the crop is already destroyed. Every person should watch his fields closely and when the least suspicious damage appears, determine the cause, either by his own investigation or by calling someone who knows. It is too often the policy of farmers to put off making such preparations even though they realize that weevil injury was present in their fields to a considerable extent during past seasons.

CONTROL EXPERIMENTS IN 1920

In the experimental work carried on at Paonia, spraying has been the most economical and successful method tried for the control of the alfalfa weevil and during the past year has received the most attention. It is hoped that practical control methods can be established by the time they are needed over any considerable territory of the State.

With one exception, the sprayed plots showed the same degree of efficiency as in 1918 and 1919. One plot failed to give the protection that one spray normally affords, but a study of the conditions reveals a possible explanation of the result. Plate VII shows graphically the results obtained on this particular plot, designated as Plot 2, as compared with one where good protection was secured.

Plot No. 2 was located in the center of the first infestation found in the State. This field had never been sprayed for alfalfa weevil previous to 1920, because it was used for parasite rearing during 1918 and 1919. Although the parasite (*Bathyplectes curculionis*) became well established in this field and spread to adjoining fields, it could not cope with the rapid increase of the weevil. Comparing the checks in the two plots, it will be noted that Plot No. 2 had an infestation twice as great as No. 1. The former, at the height of larval activity, gave 23,080 larvae per 100 sweeps of the insect net,

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while the latter only reached 13,760. A summation of the nine days of maximum catch for Plot No. 2 gave 136,834 larvae collected in 900 sweeps of the insect net, while Plot No. 1 gave 66,700 larvae over the same period. Plot No. 2 was sprayed eleven days earlies than Plot No. 1 because injury appeared earlier. Plot No. 1 should have been sprayed five days earlier, but rush of work at the time prevented. Note that the number of larvae on the crop at cutting time was three times as great on Plot No. 2 as on Plot No. 1. Based on the checks, the efficiency of the spray on Plot No. 2 was 85.6 percent, while on Plot No. 1 it was 78.8 percent, but the number of larvae remaining on the crop in Plot No. 2 was sufficient to cause considerable loss. The second crop of Plot No. 2 was also retarded by the larvae feeding upon the new growth. The first cutting on Plot No. 1 matured well and the second crop started without showing any retarding effect of the weevil.

Plot No. 1 is located under about the same conditions as Plot No. 2, but was sprayed for weevil during 1918 and 1919. Although this is the first case to come to the attention of the writer wherein one spray would not effectively protect the crop, it does indicate that there may be an accumulative or carry-over effect derived by spraying on previous years. It is not supposed that this accumulative control will ever allow the omission of control work for any season, but it is hoped that it will insure satisfactory control by the annual application of one spray.

PLANS FOR FUTURE EXPERIMENTS

Co-operative experiments are being formulated between the states of Idaho, Utah and Colorado for the season of 1920 to try out the possibility of using dust sprays for alfalfa-weevil control. Their use is a new venture, first tried out in Idaho last year to a small extent. It has several advantages over the liquid sprays providing it proves to be efficient.

SPREAD OF THE WEEVIL PARASITE IN COLORADO

It is gratifying to note that the parasite, *Bathyplectes cursulionis*, has spread over the entire weevil-infested area in Delta and Montrose Counties. In 1920, parasitism ranged from a fraction of one percent in some fields, up to thirty percent in Mr. Chase's field on Redlands Mesa. Just how much good this parasite is doing cannot be estimated, but we do not believe that it, alone, can keep the weevil in check. It is hoped that sometime enough of the natural enemies of the weevil may be established in this country to give a substantial

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degree of protection. Reliable investigators state that in Europe there are many other enemies which destroy the weevil in its different stages of development.

REPORT ON RODENT PEST WORK AND TWO INJURIOUS BIRDS

W. L. BURNETT

Since in former years the rodent work has been carried on along similar lines, and full reports on the activities were made, only the outstanding points of the work of the past year are given in this paper.

I am including a brief report on some work done during the year on two birds that promise to become serious pests to certain agricultural areas in the State, unless repressive measures are soon taken to keep them in check.

Rodent control work was carried on very extensively throughout the State in 1920.

A number of new pest districts were organized in different counties and splendid co-operation has been given this office by the farmers, county officials and county extension agents.

In several of the counties the tendency has been to organize at one time a larger territory than can be adequately taken care of in a season. Not only has the territory been too large in some cases for one inspector to look after the final cleanup in these districts, but the expense to the counties in these areas to exterminate the rodents on non-resident land and advance payment until taxes are collectable, has been so great that the work has been badly handicapped.

With one inspector about six or eight townships are all that can be successfully handled in one season, and these should, by all means, be cleaned up before more districts are set aside.

As the rodents are no respectors of townships or county lines, boundary lines are one of our most serious problems in pest extermination. The farmers contend, and rightly so, that if the rodents are exterminated in a township and not in the adjoining one, the township free from pests will be reinfested from the infested one. It is impossible at this time not to have boundary lines, for the reasons, that the State is large, pests are numerous, and infestation extensive.

The boundary lines of pest districts should be taken care of until such time as the adjoining territory can be looked after and boundary lines eliminated. If we should start at this time to eliminate boundary lines they would have to be extended almost indefinitely.

What we would like to see is an entire county cleaned up from some one rodent pest, and, next season, we have

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hopes of reporting a final cleanup in some one of our counties, on prairie-dogs.

Logan County at the present time is about as near clean as any county in the State where the infestation has been extensive.

Mr. Morrison, County Pest Inspector for Logan County, estimates the infestation of prairie-dogs in his county at the present time (October) at about 1,000 acres. Logan County, in the past has been one of the heavily infested counties.

As an illustration of the growth of the rodent pest extermination movement in the past few years in Colorado, it is only necessary to state, that at a meeting of the State Farm Bureau at Fort Collins, Jan. 12, 13, and 14, nineteen of the twenty-four counties represented had prairie-dog or ground-squirrel control as one of their projects.

PRAIRIE DOGS

In the southwestern counties the prairie-dog, known as *Zuniensis,* still presents a problem in control measures, as it does not eat poisoned grain readily, at least at certain times during the year. However, Mr. G. P. Newsom, County Agent for Montezuma County, has gotten better results this past season than heretofore by using a modification of our formula No. 46. This modified formula is as follows:

Recleaned oats	120 qts.
Strychnine (alkaloid powdered)	10 oz.
Saccharin	1 oz.
Flour	2½ pts.
Soda	10 oz.
Glycerine	1 pt.
Water	10 pts.
Salt	5 pts.

Glycerine was used instead of petrolatum oil for the reason that the oil was not obtainable in that section.

Mr. Newsom comments on the use of the modified formula as follows:

"About May first, reports began to come in more favorably. Mr. Elmer Millard, of the Aztec Community, reported that he had excellent results May first. On May fourth, the County Agent went to his ranch and the two gathered up fifty-one dead dogs on top of the ground from forty acres of land, from the use of four gallons of bait. Ern Higman reports thirty-seven dogs dead from using one gallon of bait on green alfalfa ground. W. H. Carlile reports fifty-eight dead dogs on top from one application about May 20th. H. T. Thomas reports twenty-seven dead dogs from the use of one gallon of bait on green hay land. In June the County Agent spread less than one gallon along the roadway and got thirty-three dead dogs on top."

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WYOMING GROUND SQUIRREL

Considerable time was spent by the writer on the life history of this squirrel during the season, and some very interesting data were secured, a portion of which was published as Part One, Circular No. 30, Office of the State Entomologist. The balance will be published as soon as our studies are completed.

As in former years, these squirrels have extended their range several miles, and in some localities are approaching dangerously near some of the more important agricultural centers of the State. In a majority of these sections we have been able, by the use of poisoned grain, to head off this invasion to some extent.

POCKET GOPHERS

The pocket gopher problem is becoming, each year, a more serious one. In both the mountain and plains sections they are increasing rapidly and some more efficient methods for control must be worked out before the situation can be handled successfully.

A number of experiments were carried on this season with various poison combinations. By the use of poisoned vegetables we were able to cope with the mountain species (*Thomonys*) very successfully, but with the plains gopher (*Geomys lutescens*) results were not so good.

The only explanation we have to offer at this time is that the workings of the plains gopher are at a greater depth and the runways more difficult to locate.

RING-NECKED PHEASANT

For several years past we have received complaints concerning the injurious habits of the ring-necked pheasant. Probably two-thirds of these complaints were relative to the pheasant's habit of digging out the germinated seed of corn, wheat and oats; the other third were mostly concerning the destruction of sugar beets and garden vegetables. These complaints were substantiated by our investigations of the food habits of the pheasant in Northern Colorado.

The writer was granted a special permit, by courtesy of the Colorado State Game Commissioner, to take, during the year, fifty pheasants for the study of their food habits. The work was begun in March and completed in December. The results of this study are published in State Entomologist Circular No. 31.

Our investigations do not bear out the statements that have been made through the press, that the pheasant is an in-

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sectivorous bird feeding largely on insects. They do show that the diet of the pheasant is chiefly a mixed one, consisting of grain, weed seeds, berries and leaves of plants, and some insects.

Grain, however, seems to be its first choice, and wheat its favorite grain. Insects are rather incidental to the other foods, and those taken are the ones that occur with the other food, and may be picked up with the least effort on the part of the birds.

The statement is often made by individuals and by the press, that, since the pheasants have become so numerous in the northeastern part of the State, we have had very little grasshopper trouble, and that pheasants destroy both adults and eggs in great numbers. We failed to substantiate these statements. The forty-eight birds taken and examined during the season had in their crops and stomachs, seven adult grasshoppers and no eggs.

It is true that several years ago we had serious outbreaks of grasshoppers in this section. It is also true that in the past few years, grasshoppers have been of little economic importance; however, natural control, parasitic and fungus diseases, was the important factor in reducing their numbers. Probably it is only a question of time until climatic and other conditions will be such that we shall have another outbreak of hoppers regardless of pheasants.

PINION JAYS

These jays are also known as pinion birds, and pinion squackers. Complaints have been coming to this office for several years past concerning the feeding of the pinion jays on corn in the fields and in the shock. The injury is done in the fall of the year, and in some sections the losses have been heavy. The greater number of complaints have been from the southwestern part of the State, Garfield, Montezuma, La Plata, Huerfano and Las Animas Counties.

At our suggestion, Mr. Newsom, County Agent of Montezuma County, tried out the following formula for their control:

Whole corn	16 quarts
Strychnine (Akaloid powdered)	1 ounce
Saccharin	1-8 ounce
Flour	1-2 pint
Soda (baking)	1 ounce
Water	1 pint

Dissolve the strychnine in one-half the prescribed quantity of cold water; then add the other half in warm water, stir in the saccharin and soda, and. when dissolved, add flour, put over a fire and heat until the flour begins to thicken, stirring constantly. Pour the poisoned solution over the grain and mix thoroughly.

We would suggest the following changes in the directions for mixing, after "Stir in the saccharin and soda": Put over

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fire and heat almost to the boiling point, stirring constantly. Remove from the fire, and stir in flour to make a creamy paste.

When the grain is mixed, it is ready to use. Scatter around the edges of the fields, or where birds are feeding.

Mr. Newsom reports as follows on the use of this formula:

"This was tried out when the birds first began to bother in the fall of 1920, and gave complete relief. This was advertised and bait placed at convenient distributing points. All reports that have been received are that the bait gives complete relief. This could not be worth less than $1,000.00 to the farmers of this county."

POISON GRAIN PREPARED FOR RODENTS.

The amount of poisoned grain shipped from Fort Collins during the season of 1920, was 14,932 gallons, an increase of 364 gallons over the amount shipped in 1919.

The amount of grain prepared by the Biological Survey was 5,811 gallons, or 16,636 less than in 1919, which makes the grand total 10,713 gallons less than in 1919.

In the preparation of this poisoned grain, approximately 7,219 ounces of strychnine were used at a cost of $13,355.15.

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DISTRIBUTION OF POISONED GRAIN IN 1920

Counties	No. of Gallons of poisoned grain shipped from Fort Collins	No. of Gallons poisoned grain prepared locally by the Biological Survey for public land	No. of Gallons poisoned grain prepared locally by the Biological Survey for private lands.	No. of gallons poisoned grain prepared locally by county organizations	Approximate number of acres treated.
Arapahoe...	2,061	....	....	....	41,220
Adams.....	863	....	....	....	17.260
Archuleta..	90	....	....	....	1,800
Bent.....	231	....	....	....	4,620
Bacca.....	13	....	....	....	260
Boulder.....	107	....	....	....	2,140
Costilla.....	197	....	....	....	3,940
Custer.....	360	....	....	250	12,200
Cheyenne...	7	....	....	....	140
Chaffee.....	18	200	....	....	4,360
Conejos....	2	....	....	....	40
Delta.....	....	99	521	....	12,400
Douglass	782	209	....	....	19,820
El Paso....	345	....	....	....	6,900
Eagle.....	93	....	....	375	9,360
Elbert.....	3,845	....	....	....	76,900
Fremont....	57	....	734	....	15,820
Grand.....	176	....	....	....	3,520
Gunnison...	153	....	....	....	3,060
Huerfano...	51	267	160	....	9,560
Jackson....	3	....	....	....	60
Jefferson...	68	....	....	....	1,360
Kit Carson.	42	....	....	500	10.840
Lincoln.....	338	....	....	300	12,760
Las Animas	1,096	....	....	....	29,220
La Plata...	....	90	100	....	3,800
Logan....	101	....	....	....	2,020
Larimer....	1,102	466	....	....	31,360
Mesa.....	107	....	....	....	2,140
Morgan....	141	....	....	....	2,820
Montezuma.	8	209	....	....	4,340
Moffat.....	20	410	....	2,300	54,600
Montrose...		196	571	....	15,340
Otero.....	506	....	....	....	10,120
Ouray.....		....	....	300	6,000
Park.....	5	50	....	....	1,100
Prowers....	47	....	....	....	940
Pueblo.....	400	....	....	....	8,000
Rio Blanco.	1	....	....	....	20
Rio Grande.	....	206	265	....	9,420
Routt.....	....	390	....	1,500	37,800
San Juan..	25	....	....	....	500
Saguache...	3	....	480	....	13,580
San Miguel.	10	....	....	....	200
Teller.....	83	....	....	....	1.660
Washington	56	196	....	....	1,120
Weld.....	1,312	....	....	....	26,240
Yuma.....	17	....	....	....	340
Totals.....	14,932	2.980	2,831	5,225	533,020

Total gallons of poisoned grain used for the year, 26,268.

APIARY INSPECTION

Mr. Wesley Foster, a beekeeper of Boulder, has acted as deputy in charge of the apiary inspection. The funds would permit Mr. Foster to put in only part time, so practically all the actual inspection work has been done by the county apiary inspectors and the counties not providing such inspectors have gone without protection against the bee diseases.

While most of the county inspectors have the inspection work well in hand and the foul brood is not seriously reducing

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the honey yield in any county, a closer supervision of the inspection work is very important. It is hoped that with the increased interest that exists in the bee work in all sections an increase in the funds for this important work can be secured. The large number of new and inexperienced beekeepers who have recently taken up the work make a much stronger demand for more time to be given to educational work. It has been the policy of the office to consider the educational phases of the work the most important and it is regretted that funds will not permit Mr. Foster to give full time to the development of the beekeeping industry of the State.

LIST OF COUNTY APIARY INSPECTORS

W. C. EVANS	Fort Collins	Larimer County
S. A. MENDUM	Boulder	Boulder County
WALTER MARTIN	Brighton	Adams County
N. L. HENTHORNE	Platteville	Weld County
GEO. R. GILMORE	Fort Morgan	Morgan County
CHAS. HOLLINGSHEAD	Sterling	Logan County
W. H. BIRNEY	Las Animas	Bent County
GEO. L. McMANNAN	Carlton	Prowers County
HARRY INGALLS	Ordway	Crowley County
A. S. PARSONS	Rocky Ford	Otero County
E. D. SMITH	Durango	La Plata County
W. H. KENDLE	Montrose	Montrose County
J. G. JEWELL	Delta	Delta County
WM. HARKLEROAD	De Beque	Mesa County
FRANK NIEUBAUER	New Castle	Garfield County
W. L. COOPER	Pueblo	Pueblo County

BARBERRY ERADICATION

The campaign for the eradication of the common barberry (*Berberis vulgaris*) and its horticultural varieties, has been continued in co-operation with the Bureau of Plant Industry, U. S. Department of Agriculture, and the Department of Botany, Colorado Agricultural College. A large portion of the funds for the campaign have been furnished by the Bureau of Plant Industry. Mr. J. R. Fitzsimmons has been in charge and, during the summer, has had two helpers.

Considerable attention has been given to a rechecking of the cities, small towns and country homes for the destruction of any sprouts that may have come from bushes that were dug out. A much larger percentage of these bushes had developed sprouts than was expected. Some time has been given to a survey of the country sections. A few bushes are being found in all irrigated regions. In a few localities volunteer plants that have spread along streams or irrigation canals present a serious problem.

Quarantine No. 8, which forbids the importation or shipping within the State of the common barberry has been in effect. No violations have been detected. All nurserymen of the State have given hearty co-operation. All have destroyed their barberry plantings and some at a considerable financial loss.

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REPORT OF EXPERIMENTAL WORK ON CHEMICAL ERADICATION OF WHORLED MILK WEED, (*Asclepias galiodes*) SEASON 1920

W. L. MAY

On the hillsides below irrigation ditches in Montrose, Mesa and Delta Counties, there occurs much whorled milkweed which cannot be eradicated by any cultivation methods because of the rocky nature of the soil or the unevenness and steepness of the ground. Much of this milkweed is on main stock driveways and has been responsible for heavy fall losses of both cattle and sheep. So heavy have been the losses on areas of this type in some localities that it would be economical to eliminate them even at an expense that would be prohibitive if used on cultivated land merely to reclaim the land.

Spraying with herbicides seems to give the most promise of proving successful and practical for such rocky areas. In order to test out the practicability of such herbicides in killing the whorled milkweed, experiments with various chemicals have been carried on during the 1920 season. The results are in part very encouraging and warrant the continuance of the work another year.

THE EXPERIMENTAL PLOTS

The area selected for the experimental plots is situated two and one-half miles west of Paonia on the main road, on the north side of the river from Paonia to Hotchkiss, in Delta County. The hillsides at this place, below the Fire Mountain Canal, are thickly covered with milkweed. The sprayed areas were fenced in so that there would be no danger of poisoning loose stock that might eat other plants occurring with the milkweed after they had been sprayed with chemicals.

The fenced areas were staked off into plots one rod square and the plots were lettered according to the system used in the card index of notes which was kept.

NATURE OF SOIL

The formation where the plots are located is a large percent rock. It would be impossible to apply any cultivation method for the eradication of the milkweed.

METHOD OF APPLICATION

All materials were applied in the form of a spray, with a hand-spray pump. The pump was placed in an 18-gallon gal-

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vanized can, mounted on a wheelbarrow frame. In place of the regular nozzle coming with the machine, a spray rod of ½-inch pipe, 5 feet long, with regular Bean cut-off and Bean whirlpool nozzle was substituted. A pressure of 100 to 150 pounds can be maintained by steady work at the pump handle.

Root absorption of poison has not proved as efficient as leaf absorption where the two have been tried out together on perennials, hence the leaf absorption method has been used in the experiments at Paonia. Most of the applications were based on a given amount of chemical per square rod. This amount was fixed more or less arbitrarily from data obtained from various experiment stations where chemical spraying of weeds has been tried. The amount determined for any given chemical was dissolved in sufficient water to cover the foliage thoroughly, in most cases, three to five gallons per square rod being used, although the sodium arsenate was tried out in larger amounts.

USE OF SPREADER

Due to the waxy bloom on the leaves and stems of the milkweed, it is hard to spray any solution evenly over the plants. To obviate this trouble, a small amount of linseed-oil-jelly soap was used in the spray material. This was very effective in causing the material to spread evenly over the foliage. Solutions of spray materials without the soap were not tried in comparison with those containing soap.

TIME OF APPLICATION

Applications were begun as soon as the plants were three to four inches high. This occurred about May 20th. Later applications were made on new plots approximately every two weeks during the summer. Plots which sent up shoots after having been sprayed were sprayed with later applications when the shoots reached a height of three to four inches.

Copper sulphate, ferrous sulphate, common salt, crude oil and sodium arsenite were all tried out in varying strengths. Of these only the sodium arsenite proved of sufficient value to give promise of being a desirable chemical.

SODIUM ARSENITE

At the beginning of the experiments, stock solutions of sodium arsenite were prepared in three different ways.

1st. By combining sodium bicarbonate and white arsenic.
2d. By combining sodium hydroxide and white arsenic.
3d. By combining sodium carbonate and white arsenic.

The first two methods of preparation were discarded early

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in the year, largely because of the higher price of sodium bicarbonate and sodium hydroxide. The action of the sodium arsenite prepared by all methods seemed to be identical.

The stock solution made with the sodium carbonate is prepared as follows:

Three pounds of sodium carbonate are dissolved in two gallons of boiling water. After the carbonate is thoroughly dissolved, 1 pound of white arsenic, first mixed into a paste, is added and the whole allowed to cook for about twenty minutes.

The amount of application was figured to the base of pounds of white arsenic to the acre, and applications during the season were made at the rates of 8, 12, 16, 40 and 160 pounds to the acre.

Of the early treatments, beginning with May 21 and extending to early in July, only applications at the rates of 12 and 160 pounds of white arsenic per acre were made. During May and June the milkweed on all plots sprayed at the rate of 12 pounds white arsenic per acre was killed back to the ground completely. It was not long, however, until growth from underground parts was again resumed. Some plots were sprayed a second time and the new growth killed back. The weed on these plots had a hard struggle during the season, but it is not thought that the plant will show appreciable injury next year as there appeared to be very little absorption of poison into the roots, the injury being confined entirely to above-ground parts.

It was not until early in July that applications equivalent to 8 lbs. and 16 lbs. of white arsenic per acre were used. At this date the plants were becoming tough and were approaching the budding period. On all plots where smaller applications were made (i.e., applications equivalent to 8, 12 and 16 lbs. of white arsenic per acre) the killing effect after July 1st was negligible, the only results being a partial defoliation and prevention of seeding. Applications at the rate of 40 lbs. of white arsenic per acre were made in July and showed entire killing of tops, but growth was soon resumed from the underground parts. It is regrettable that applications of this amount were not continued later in the season, because results obtained with the larger applications would indicate that absorption into the roots did not begin until August 1st. It is logical to suppose that after absorption into the roots begins, a little more than the smallest amount necessary to kill all above-ground parts would result in poisoning the roots.

LARGER APPLICATIONS OF SODIUM ARSENITE

The most uniform results were obtained by the use of

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sodium arsenite at the rate of 160 lbs. of white arsenic per acre. The solution used per square rod was 2 gallons of the stock solution diluted to 8 gallons. From the first application on May 21st to the last application on Sept. 24th, the tops were entirely killed back on every plot and on these plots where any growth was resumed, the return to activity was exceedingly slow. **It was not until the application on July 29th that killing of roots resulted.** The plants at this date were in the early pod stage. On this plot and on subsequently sprayed plots, the roots were killed into the ground to a depth of at least eight or ten inches.

COMMERCIAL WEED KILLERS

Two commercial sodium arsenite weed killers were used. The results from the use of these weed killers were identical with the results from the prepared solutions of arsenic of the same strengths as the weed killers.

GENERAL CONCLUSIONS

1. The experimental work of the 1920 season warrants the continued use of only two chemicals, crude oil and sodium arsenite. The latter has given as good results in the form of commercial weed killers as in the prepared form, and unless the expense is too large, comparatively, the commercial weed killers would be more convenient to use in the field.

2. The young, early growth may be killed back by very light applications of sodium arsenite, but at the beginning of the blossoming period these light applications are inadequate.

3. Killing of the roots by absorption of sodium arsenite does not begin until after the blossoming period, but after this stage the poison penetrates to the roots.

4. The above results indicate two possible methods of control with sodium arsenite as follows:

a. The use of light applications, beginning early in the season and repeated on plots as often as necessary so as not to allow the new growth t oreach a stage too old to be effectively killed with the weak solution. The object would be to keep the tops killed to the ground throughout the season.

b. The use of stronger solutions after the blossoming period when absorption into the roots takes place, with the object of killing the plant with a single application.

The experimental work another year should be so planned as to test out the comparative efficiency and cost of these two general methods of attack.

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FINANCIAL STATEMENT

There being no receipts to account for during the year, the financia statement consists entirely of disbursements, which are as follows:

STATE ENTOMOLOGIST FUND

Salary of State Entomologist	$ 499.9
Salary and per diem of Deputies, traveling, incidental and office expense	14,131.5
Total	$14,631.4

PEST FUND

Salary of State Entomologist	$ 499.92
Per diem and expenses	1,484.79
	$ 1,984.71

APIARY INSPECTION FUND

Per diem of deputy, traveling and incidental expenses	$ 1,363.82

C. P. GILLETTE,
State Entomologist.

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Forestry

Circular 37 November, 1922

Beekeeping in Colorado

By NEWTON BOGGS

Office of State Entomologist
COLORADO AGRICULTURAL COLLEGE
Fort Collins, Colorado

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OFFICIAL STAFF

C. P. GILLETTE.....State Entomologist
GEORGE M. LIST.....Chief Deputy
W. L. BURNETT.....Deputy, Rodent Control
NEWTON BOGGS....Deputy, Apiary Inspection and Investigation
J. H. NEWTON.....Deputy Alfalfa Weevil Control
W. L. MAY.....Deputy, Weed Control
WM. P. YETTER, JR.....Deputy
C. L. CORKINS.....Deputy
E. ROBERTS.....Clerk

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BEEKEEPING IN COLORADO

Colorado has over one hundred thousand colonies of bees and produces annually between five and six million pounds of honey. These facts emphasize the importance of the beekeeping industry.

This alfalfa region is entirely different from any other in that we have almost ideal conditions to keep bees in. In the spring the colonies have a long period before the honey flow to build up in. The honey flow lasts until fall and during this time, they have a chance to rear a large number of young bees to go through the winter. Nevertheless, our winter loss averages 10 percent.

HONEY PLANTS OF COLORADO

Sweet clover is found throughout the State and is a valuable honey plant in that it yields as well as alfalfa. Being mostly in waste places, it is not used as hay thereby helping considerably between afalfa flows. Practically all surplus is secured from these two plants, with an occasional crop from **Cleome.** The rosin weed **(Grindelia squarrosa)** yields considerable honey of low grade, which often spoils the grade of the white honey by being mixed in the super. Parsley, prairie clover and **Narcissus** are prairie plants which bees work on freely. Soft maple, dandelion and fruit bloom are important for spring brood rearing. In the mountains are found several early blooming plants which are excellent for building up in the spring. In the Arkansas Valley cantaloupes yield some surplus. **Oreocarya** is a desert plant which yields surplus. Wild currant is found in the mountain canyons. Loco weeds are found in the foothills and yield some honey during May and June. Sunflowers add something to the sum total brought in by the bees.

BEEKEEPING REGIONS IN COLORADO

Very few bees are found in the non-irrigated sections of the State, therefore, divide the beekeeping part of Colorado into six regions. The territory drained by the Platte River; the territory drained by the Arkansas River; the San Luis Valley; the San Juan Basin; the territory drained by the Colorado River Basin; the territory in the northwestern section of Colorado, drained by the Bear River.

In the San Luis Valley there probably are numerous localities that would yield good returns in honey from alfalfa and sweet clover. The latter is grown considerably on waste and seep land. This region awaits the progressive beekeeper.

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Figure 1—A Well-Kept Colorado Apiary.

ALTITUDE AND NECTAR SECRETIONS

It is an established fact that flowers at high elevations and high latitudes tend to secrete nectar more freely than in opposite situations. Dr. E. F. Phillips and Dr. J. H. Lovell have reported a great deal of evidence pointing to a more profuse nectar secretion at higher elevations. A beekeeper at Grand Junction reported to the author of the American Bee Journal in June, 1919, that while three of his apiaries were getting barely enough nectar to keep them alive, three others 1800 feet higher and 35 miles away had filled the supers and he was extracting a good crop. Some of the largest crops in the State have been reported at elevations of 5,000 to 7,500 feet. In some of these locations over 300 colonies of bees have been kept in one apiary and a high average secured. At the higher elevations we tend to get a lighter colored and a somewhat better quality honey.

ADAPTATIONS OF BEEKEEPING PRACTICE FOR THIS REGION—FALL PREPARATION

We have nearly ideal conditions in the fall for the colonies to have plenty of young bees to go through the winter, in that we have a flow lasting to about September 15, and sometimes until the 1st of October. But in order to have the largest number of young bees for winter, the beekeepers should see that every colony has a vigorous young queen introduced about August 1st. The queen should have all the empty worker comb space she needs for egg laying throughout the fall. She should be capable of keeping one ten-frame Langstroth hive body at

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least nearly full of brood almost until frost. Many beekeepers, especially comb honey producers, make the mistake when they take off the supers before the end of the honey flow by not putting on hive bodies in place of the super. Their aim is to obtain plenty of honey in the brood chamber for winter stores, which is important, but no more than having a large force of young bees.

Young queens introduced in the fall greatly reduce the number of failing queens in the spring, when a good queen is needed most.

Provide Adequate Stores: While rearing brood heavily in the apiary a colony will consume honey very rapidly. It is estimated that a colony of bees that has an equivalent of 12 Longstroth frames of brood in the hive by June 15th, will consume at least ninety pounds of honey from the time of the first killing frost in the fall to June 15th of the next year.

The weather during the spring is frequently unfavorable for bee flights for long periods of time, and also for nectar secretion. To make the bees independent of the weather, let's meet nature half way and provide an extra hive body (about 45 pounds of honey) full of honey, to be placed on top of the brood chamber the previous fall.

In order to conserve the energy of the bees, we should provide protection in the fall at the time of the first killing frost. All honey coming into the hive stops, causing the colony to cease brood rearing. At this time the bees are the quietest of any period of the year. The disturbance incident to putting on insulation does not do them any harm. After this the beekeeper should have no occasion to open the hive until spring.

If packing is delayed until late, it may do far more damage than to leave the bees unpacked. A colony of bees that is generating heat in response to low temperature is considerably disturbed by the manipulations during packing and the temperature of the inside of the cluster is promptly raised. Frequently, if bees are packed too late the cluster temperature is raised to brood-rearing temperature, the queen begins to lay eggs, and brood rearing is usually continued through the winter unless it results in the death of the colony. Many beekeepers pack their colonies in December with most harmful results.

Time for Unpacking: If the bees have been properly prepared the previous fall, with a young queen, plenty of stores and well packed, the beekeeper rarely has any reason for opening the hive until spring is well advanced. It is best to leave the insulation on until the bees need more room, which will probably be about June 1st, on the weaker colonies somewhat longer.

Methods of Packing: The exact matter of packing is not especially

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important provided insulation is provided on all sides including the bottom. If colonies are packed in long rows, there is the objection that the bees drift from the weaker colonies to the stronger ones. If arranged in groups of four (Fig. 2), two facing east and two west, they may be left on the same stand throughout the year and are readily manipulated during the summer.

Figure 2—A Four-colony Winter Case.

There are several methods of providing extra protection to the colonies for outdoor wintering. It is hardly possible to describe even briefly any one plan in detail in this short article.

Too much value can hardly be placed on a good windbreak. Evergreens so placed as to break the wind from the north and west are very good. If these can not be provided, the apiary should be placed in a gulch on the leeward side of the hill, or in a grove of trees. Too much reliance should not be placed in buildings as windbreaks, for they often serve to divert the wind slightly.

Having put the bees away for the winter in good condition the beekeeper can next look forward to the coming of spring and the resumption of activity again. If the details have been attended to properly one need have little fear for the bees coming through the winter in good condition and ready for the work of the season.

SPRING MANAGEMENT

The outstanding thing in the spring is to provide the conditions necessary permitting the bees to get the maximum crop and be ready for the honey flow. All the work which occurs in the spring should have been done the fall before.

Plenty of Stores: If there has not been enough honey left with the colony in the fall provision must be made to feed the colony in the spring a good syrup made from two parts of water to one of granulated

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sugar. A simple feeder may be made from a friction top can by punching with a nail a few holes in the center of the cover. Fill the can with warm syrup and place it bottom up over the hole in the inner cover. Place an empty hive body on to protect the feeder. Place the cover on the super. The syrup should flow from the can fast enough to be taken up in from twelve to twenty-four hours.

Plenty of Room: Remember to give your queen plenty of room for brood rearing. Many good queens become honey bound during the dandelion flow. Avoid this by putting on an extra hive body as soon

Figure 3—A Shop for Retailing Honey. In this way much honey can be disposed of locally to a good advantage.

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as conditions seem to warrant it. A good queen should brood in twelve frames just before the main honey flow.

Protection: Do not be in a hurry to remove the winter packing. Some beekeepers make the mistake of removing the packing in April. If bees were put in their winter quarters in proper condition they should not be unpacked until about the time of the last killing frost. If for any reason it seems necessary to open up the brood, be sure to do it on a warm day when the bees are flying freely.

Water: Bees use considerable water during the time of brood rearing. It is a good policy to provide water near the apiary. This sometimes helps to keep the bees from gathering water where spraying has been done.

Robbing: Bees are prone to rob at this time of the year. Take all precautions to guard against this as it may be the means of spreading diseases as well as loss of colonies.

SUMMER MANAGEMENT

If you have had success in bringing your colonies up to their proper strength for this time of the year, you are now facing the problem of preventing all possible swarming, which if not controlled, will render your colony useless or nearly so when it comes to producing a surplus of honey. Swarm control is one of the most important problems of the beekeeper at this time of year. The thing that makes the problem difficult is the fact that the beekeeper is here working against the natural instinct of the bee.

If the colony is strong at the beginning of the honey flow and shows indications of swarming, it may be divided artificially. Some methods of management may call for examination of colonies periodically to cut out queen cells, and to keep queens clipped to prevent swarms leaving, but this entails a large amount of work and even though the queens are clipped, will not prevent the desire on the part of the bees to swarm, nor will it prevent the effort to swarm with subsequent loss of time in honey production.

We should strive to so manipulate the colonies that we may keep the impulse to swarm at the minimum.

The requisites to prevent swarming may be summarized as follows: a minimum of drone comb, ample breeding room, plenty of storage room for honey, young queens, and ample ventilation.

Drone Comb: The use of full sheets of foundation, both in the brood chamber and in super frames will to a large extent do away

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with a superabundance of drone comb in the hive. It will pay well to discard such combs completely and wire the frames properly and insert full sheets of foundation.

Figure 5—A colony should have the equivalent of three supers for storage.

Large Brood Chamber: Many apiarists using the eight or ten frame Langstroth hive expand the brood chamber by adding another story for the queen as soon as the first one restricts her laying. Their plan, then, is to restrict the queen from the original brood chamber again to the lower story with one frame of brood at the beginning of the first good flow by means of the queen excluder and placing the remaining brood in the top hive away from the queen to insure the largest possible breeding room under existing conditions.

Ventilation: The entrance should be expanded to suit the needs of the growing colony. The beekeeper should keep well ahead of his bees giving finally a full width entrance. In the height of the honey flow and during intense heat a two-inch entrance is not excessive.

Young Vigorous Queens: It is evident that the desire to swarm is generally stronger in colonies headed by old queens, so that young queens are desirable. A good poultryman seldom keeps a hen over one year old for egg laying. So it is the same with the beekeeper in keeping queens under two years old.

Plenty of Storage Room: The beekeeper should provide plenty of room for the storage of honey, otherwise the brood chamber will become crowded with honey, thereby restricting the queen in her laying. Adding another super when the one below is about half full is the usual procedure.

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HOW TO CONTROL FOULBROOD

Ridding Colorado apiaries of foulbrood is almost entirely in the hands of the beekeepers themselves. Through cooperative effort only can the amount of disease be reduced to a minimum. In counties where inspectors are paid and educational work is being carried on, they are getting the better of the disease.

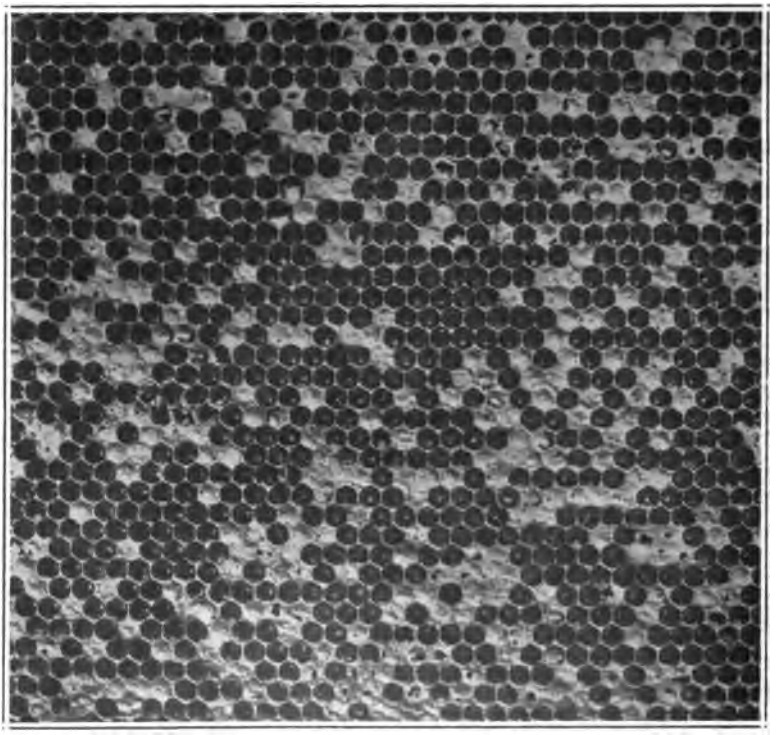

Figure 6—American Foulbrood in an Advanced Stage. Courtesy American Bee Journal.

The three brood diseases more or less common in Colorado are American foulbrood, European foulbrood and sacbrood.

American foulbrood occurs wherever it has been carried either by human agencies or by the bees themselves. As far as the writer knows, European foulbrood in the last few years has occurred only in two localities in this state. It is a disease which should not cause much trouble in the alfalfa region.

Sacbrood is more widespread and occurs during the spring in most apiaries in the State.

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Bacteria Cause American and European Foulbrood: White* has clearly demonstrated that the three brood diseases of bees known as American and European foulbrood and sacbrood are caused by bacteria. The bacteria may be isolated and the disease transmitted in the laboratory as well as in the field, sacbrood according to his investigations is a filterable virus.

Each disease develops symptoms peculiar to itself. The only sure way of determining the kind of disease is through a microscopical examination. If the beekeeper finds diseased brood and does not know what it is, he can cut out a sample and send it to the State Apiary Inspector.

SYMPTOMS OF AMERICAN FOULBROOD

In case sufficient numbers of the bacillus foulbrood gain entrance to the alimentary tract of the young bee brood, American foulbrood is bound to result. When these extremely small germs are given to the brood they multiply very rapidly and produce a poison which is fatal to the brood. When the brood dies, the germs do not die, but remain in the decomposing matter ready to contaminate any further brood they may reach. Because of their large numbers, vitality and small size they are easily spread.

Odor: American foulbrood develops the characteristic sickening odor. This odor is distinctive, sometimes called the glue-pot odor, and is strongest in brood dead for several weeks.

Ropiness: Brood that has been dead several weeks decomposes to a coffee-brown mass on the lower side of the cell. In this stage if a toothpick, match or a similar probe be inserted in the mass and drawn slowly out, the mass can be strung out from one to three inches before breaking. In time this mass will dry down and form a scale which adheres to the lower side of the cell wall.

Age: Brood is only infected during the feeding stage. Death usually comes during the last two days preceding pupation or sometimes during the first two days of the pupal period.

Cappings: The cappings of infected brood cells darken and become sunken as a consequence of the decaying matter within. When the time comes for the brood to hatch normally, the attendant bees gnaw a small hole through the cappings to investigate, resulting in the "pepperbox" appearance.

Vigor of the germ: The germ exists in a series of stages, convertible into each other, and called the vegatative condition, the motile

*G. F. White—Sacbrood: Bulletin 431, U. S. Dept. of Agr., 1917.
American Foulbrood: Bulletin 809, U. S. Dept. of Agr., 1920.
European Foulbrood: Bulletin 810, U. S. Dept. of Agr., 1920.

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condition and the spore condition. It is in the last of these, in the spore, that the germ is so hard to destroy.

It requires heating for eleven minutes to the boiling point of water to kill all spores. If the spores are mixed with honey it requires thirty minutes of such heating to destroy all. When kept dry at ordinary temperatures the spores are known to remain alive for several years.

Symptoms of European Foulbrood: Larvae usually die in younger stages and before cells are capped over. We sometimes find the cells capped and perforated as in American foul brood. The dead brood does not give off a strong offensive glue-pot odor, except in cases where other putrefying bodies are present. The dead larvae are a grayish yellow at first and later turn to a chocolate brown. They melt down and are found mostly at the back of the cell. The tissues do not string out as much as the larvae of American foulbrood, and when it does string it is of a granular consistency. The disease is generally more prevalent during the first part of the season.

Treatment of European Foulbrood: It is not necessary to destroy the combs in European foulbrood but remove the old queen and in seven days destroy all queen cells that have started and introduce a young Italian queen, and the bees will generally remove all diseased larvae in that time.

Figure 4—Display, Weld County Fair, 1922. This is an excellent way to advertise.

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General symptoms of Sacbrood: In sacbrood the larvae die after the cells are capped and the bees remove the capping or puncture the cells as in American foulbrood. However, there is a difference in that the sacbrood punctures are larger and usually only one. The larvae turns black and curls up, and can be easily removed. When punctured the larvae appears as a granular mass with more or less watery appearance.

Treatment of Sacbrood: The disease at its worst is not very destructive, and when it does make its appearance it affects so few larvae in the colony that it need not cause any great alarm.

HOW FOULBROOD IS SPREAD

Shipping bees: According to the report of the State Entomologist for 1917-18, Bulletin 20, Wisconsin State Department of Agriculture, the spread of American foulbrood from one state to another or over widely separated areas, is due to shipping diseased bees and infected equipment or honey.

Aside from buying diseased bees and shipping them into disease free territory, the buying of used combs and equipment is one of the most dangerous things a beekeeper can do. Generally the beekeeper that has old equipment to sell has lost his bees from disease. Old combs from such sources generally carry disease and should **never be used.**

Second-hand hives and equipment should never be used without first scraping and scorching or washing them in hot lye water.

Spread of disease locally is caused by exposing infected honey to robber bees or interchanging infected combs from diseased to healthy colonies.

Brood-free dry extracting combs from colonies infected with the disease should never be used, as the amount of disease carried is 25 percent.*

Feeding the bees extracted honey is dangerous even though one may not suspect disease in his apiary. If disease is in the locality, one may overlook it until it is too late. It is much better to feed sugar syrup.

Disease in Buildings, Trees and Rocks: In inspection work one is frequently met by the statement that it is of no value to clean up foulbrood in his apiaries as long as the bees in trees, crevices in the rocks, between the walls of buildings, etc., cannot be inspected, as the disease will be redistributed over the area from this source. It is true

*H. F. Wilson, Bulletin 333, "How to Control American Foulbrood". Agricultural Experiment Station, University of Wisconsin.

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that bees in these places are a menace, but their number is so small in comparison with bees in hives that it has been found to be a negligible influence.

TREATMENT OF AMERICAN FOULBROOD

Figure 7—Brood stacked over a weak colony to be treated later. Courtesy American Bee Journal.

The treatment of American foulbrood consists primarily in the elimination or removal of the cause of the disease. In treating this disease the aim of the manipulation is to destroy all of the bacteria of American foulbrood by the removal of all infected material from the colony, and in compelling the bees to take a fresh start by building new comb and gathering fresh stores. This is done by brushing the bees from the old combs into a clean hive.

Time of Treatment: The brushing treatment should be given during a honey flow, so that other bees in the apiary will not be inclined to rob.

Operations—1: The colony, in the evening after bees have quit flying, should be moved out of the apiary a distance of at least two hundred feet in a so-called hospital yard and left undisturbed a few days until the bees have marked their new location.

2. Select an empty hive body that is bee-tight to receive the diseased combs, and nail a tight bottom to it. Then place a cover on it.

3. Have a brood chamber containing full sheets of foundation ready. Place an empty hive on this to brush the bees into.

4. Place the clean hive body containing full sheets of foundation with bottom board and queen excluding zinc over the entrance in place of the diseased colony which has been moved back a few feet. The queen-excluding zinc will help to keep the colony from absconding.

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5. Carefully remove the frames from the diseased colony and brush the bees in the empty super above the hive containing foundation.

6. **As soon as the colony has been treated remove all infected comb and hives to the honey house, the wax to be melted up and hives cleaned immediately.**

Saving Healthy Brood: If several colonies are being treated at one time, it may pay to stack several hive bodies containing diseased combs, over a weak diseased colony to allow the healthy brood to emerge, thereby strengthening the weak colony. **This colony should be treated in 21 days and all combs rendered into wax.**

Cleaning the equipment: After the bees have been brushed into clean hives, the next step is to prepare the hives for use again. The frames should be boiled in lye water and then while hot dipped in another tank of hot water to clean them off. The covers, bottoms and hive bodies should be scraped thoroughly on the inside, corners, edges, and backs of rabbets, and then washed in a strong lye solution. **Melt up all the combs and dispose of the honey at once.** Some beekeepers go so far as to burn or bury all the combs on the spot.

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CIRCULAR 38 JUNE, 1923

FOURTEENTH ANNUAL REPORT

of the

STATE ENTOMOLOGIST

OF COLORADO

For the Year 1922

OFFICE OF STATE ENTOMOLOGIST
Colorado Agricultural College
Fort Collins, Colorado

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CIRCULAR 38 JUNE, 1923

Fourteenth Annual Report

of the

State Entomologist

of Colorado

FOR THE YEAR 1922

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Colorado Agricultural College
Fort Collins, Colorado

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OFFICIAL STAFF

CLARENCE P. GILLETTE	State Entomologist
GEORGE M. LIST	Chief Deputy
WILLIAM L. BURNETT	Deputy in Charge of Rodent Control
NEWTON BOGGS	Deputy in Charge of Apiary Inspection
J. H. NEWTON	Deputy in Charge Alfalfa Weevil Control
W. L. MAY	Deputy in Charge Weed Control
WM. P. YETTER, JR.	Deputy
C. L. CORKINS	Deputy
E. ROBERTS	Clerk and Stenographer

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LETTER OF TRANSMITTAL

To the Secretary of the State Board of Agriculture:

Sir:—In compliance with the laws of the State of Colorado, I have the honor to submit herewith my Annual Report as State Entomologist, containing a summary of the work of the office for the past fiscal year.

C. P. GILLETTE,
State Entomologist.

Fort Collins, Colorado.
November 30, 1922.

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FOURTEENTH ANNUAL REPORT

OF THE

STATE ENTOMOLOGIST

OF COLORADO

C. P. GILLETTE, *State Entomologist*

GEORGE M. LIST, *Chief Deputy*

The work of the office of State Entomologist is provided for by three acts passed by the General Assembly of Colorado, known as the State Entomologist Act, the Pest Inspection Act, and the Apiary Inspection Act. These acts provide for the following lines of work:

1. Inspection of the nursery stock coming into the State.
2. Inspection of the nurseries of the State.
3. Protection of the State or parts of the State from the introduction of new plant pests by the issuing and enforcement of plant quarantines.
4. The control of insect, rodent and weed pests, and plant diseases through certain regulatory plans, through educational methods and development of better control practices.
5. Protection and fostering of the honey production through the control of bee diseases and the development and introduction of better methods of apiary management.

These laws call for the cooperation of the various counties of the State by the appointment of horticultural inspectors, pest inspectors and apiary inspectors. A considerable portion of the actual inspection and regulatory work is done by these men who are in close touch with local conditions in their respective counties. This leaves the time of the State workers largely for supervisory work and for the educational and experimental phases which are always important and often the basis of all control work.

The organization and educational work which has been carried on in connection with the various control campaigns has been in cooperation with the Extension Service of the Agricultural College and especially with the county extension agent system. A great deal of work of this nature has been done by the county inspectors, as practically all inspection or regulatory work can be made educational. The correspondence, especially in connection with the insect and rodent work of the State, has been heavy and is a most important phase of the work, as it brings the office into contact with many people and problems of the State.

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It has been advisable to give a great amount of attention to further studies of the life history of and control methods for the major pests as these, even if they have been studied in other sections, must be worked out for our conditions of climate, altitude, and crops, and new problems are constantly developing. These studies have been carried on in the closest cooperation with the Agricultural Experiment Station. In fact, men for certain lines of work have been employed jointly and parts of the data collected have been or will be published as Experiment Station bulletins as more general distribution of the information can be secured.

No changes have been made in the personnel of the staff during the year. Besides the regular workers the following men were employed during the summer months as helpers under the direction of the more experienced men: J. L. Hamilton, H. L. Sweetman, F. C. Hottes, and Carl A. Bjurman.

Besides the work carried on at the central office, insectaries have been maintained at Paonia and Grand Junction. The Paonia office has been in charge of J. H. Newton with J. L. Hamilton as assistant. Their main problems have been the alfalfa weevil and codling moth. However, considerable time has been given to other pests of the region.

Mr. W. L. May has also been stationed at Paonia working on weed control. Through an exchange of work at this station during the busy seasons more has been accomplished on both the insect and weed problems.

The Grand Junction work has consisted mostly of codling moth studies and control. Mr. W. P. Yetter, Jr., has been in charge with H. L. Sweetman as assistant. The major portion of the time of Mr. C. L. Corkins has been given to grasshopper control. At seasons when this work was not pressing he has assisted Mr. W. L. Burnett with the rodent control operations.

In a report of this nature it is impossible to give detailed information in regard to the many pest problems that have been dealt with and the duties of the various workers. The work as a whole has progressed in a satisfactory manner and the cooperation and appreciation received from the people of the State has made the work most pleasant. Many problems have not been given the attention their importance would justify, but with an annual loss from insects alone amounting to probably ten percent of the agricultural production, and with losses from rodents that have been estimated at from 5 to 10 millions of dollars annually, this condition will continue.

COUNTY INSPECTORS

Much of the success of some phases of the work has been due to the cooperation of the counties of the State through their county inspectors. These men have handled most of the details of the inspection of the incoming nursery stock, the enforcement of plant quarantines, and the inspection of the apiaries, and have been very essential in the successful operation of the pest districts which comprise over

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two million acres of land for the control of insect, rodent and weed pests. Many of these men have taken an active part in pest-control campaigns that have been waged in unorganized sections.

Following is a list of the county horticultural and pest inspectors. A list of the apiary inspectors is given in the report of the deputy in charge of apiary inspection. Those with no asterisk following their names are pest inspectors; those with an asterisk are horticultural inspectors, and those with two asterisks are acting as both horticultural and pest inspectors.

Counties	Inspectors	Deputies	Addresses
Adams	J. T. Robertson	W. E. Denman	Brighton
Arapahoe	A. H. Tedmon	S. H. Hanks	Littleton
Boulder	T. B. Holman*		Boulder
Delta	R. S. Purtee*		Paonia
Delta		Roy Gregg*	Delta
Denver	G. A. Klaiber*	I. Lederer*	Denver
Douglas	Raymond Miller		Castle Rock
Elbert	A. W. Aicher		Kiowa
El Paso	F. P. McKown*		Colorado Springs
El Paso	J. C. Hale		Colorado Springs
Fremont	A. J. Taylor*		Canon City
Fremont	W. H. Pigg		Canon City
Jefferson	K. A. McKaskill		Golden
Larimer	D. C. Bascom		Fort Collins
Larimer	J. J. Noble*		Loveland
Lincoln	G. P. Newsom		Hugo
Logan	J. E. Morrison		Sterling
Mesa	L. E. Jaynes**	Chas. Jaquett*	Grand Junction
Montrose	L. E. Ross**		Montrose
Montrose	L. W. Willis		Nucla
Morgan	R. H. Sims		Fort Morgan
Otero	W. F. Droge		Rocky Ford
Otero	H. E. Mason*		La Junta
Ouray	B. B. Slick		Ouray
Pueblo	W. H. Sawhill*		Pueblo
San Miguel	F. T. Baldwin		Norwood
Washington	R. W. Vance		Akron
Weld	H. H. Simpson		Greeley

NURSERY STOCK INSPECTED

The following table gives a list of the incoming nursery stock inspected by the county horticultural inspectors in the more important fruit-growing counties. This does not include the stock that was shipped in by parcel post as our appropriation and organization do not permit of its inspection. This is unfortunate as the amount of nursery stock arriving by parcel post is rapidly increasing.

The nursery stock was generally of good quality and in most cases free from insect pests and diseases. Crown gall and borers were the principal causes for the condemnation of stock. Some shipments were returned or destroyed that were sent in violation of State or Federal quarantines. Our law requires that all shipments bear certificates showing that the nursery from which the shipment originated has been inspected within a year by a duly authorized inspector and found free

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NURSERY STOCK INSPECTED BY HORTICULTURAL INSPECTORS DURING 1922

County	Number of Shipments	Apple	Pear	Peach	Prune Plum Apricot	Cherry	Grape	Currant Gooseberry	Shade	Blackberry Raspberry Dewberry	Ornamental Shrubs	Seedlings	Miscellaneous	Total	Plants Condemned
Boulder	26	834	.....	.....	650	939	403	230	420	212	480	.....	.....	4,168	15
Delta	164	21,221	1,871	21.836	7.306	1,217	9,855	375	725	4,156	1,630	4,000	7,800	81,992	215
Denver	233	5,268	169	438	2,389	5,225	5,101	1,798	14,146	26,156	35,601	100	28,018	124,409	540
El Paso	13	235	11	10	446	568	102	2,125	3,450	812	3,454	500	1,150	12,863	....
Fremont ...	62	630	24	.....	65	1,150	1,225	730	161	280	465	.....	.....	4,730	22
Larimer ...	94	3,979	48	43	1,199	11,100	1,983	231	1,525	7,465	2,347	25,100	.....	55,020	186
Mesa	155	3,870	32,285	47,806	3,384	391	26,536	778	1,864	9,803	1,221	.....	42,151	170,089	1,638
Montrose ...	75	1,071	72	854	281	155	980	96	522	3,361	718	.....	102	8,212	....
Otero	159	431	35	67	508	847	6,138	72	1,461	997	1,733	5,450	150	17,889	34
Pueblo	78	842	373	50	980	3,673	5,169	411	188	10,586	4,863	.....	44	27,179	9
Total 1.059		38,381	34,888	71,104	17,208	25,265	57,492	6,846	24,462	63,828	52,512	35,150	79,415	506,550	2,659

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from especially injurious insect pests or plant diseases, and a certificate showing that the hardy stock has been fumigated with hydrocyanic acid gas. Some shipments were returned on account of the lack of these certificates.

NURSERY INSPECTION

All nurseries of the State are inspected at least once each year and where it is thought advisable more inspections are made. The effort has been made to make these inspections of as much educational value as possible and thus enable the nurserymen to keep their nurseries free from pests and diseases or keep any pests under control and thus avoid any restrictions that might become necessary if outbreaks occurred. This service has been appreciated by the nurserymen and practically all have given their hearty cooperation. One certificate was withheld temporarily until certain clean-up work could be done, while three were granted with certain restrictions on the handling of elm trees which were found to be infested with European elm scale. One large block of maple was sprayed for the control of the cottony maple scale.

The importance of keeping the nurseries of the State free from insect pests and plant diseases is readily apparent to all. One infested nursery might easily be the cause of a serious pest being disseminated over the entire country. Most nurserymen appreciate this danger and realize its importance to their customers.

The most important insect pests and plant diseases found in nurseries of the State were European elm scale, cottony maple scale, oyster shell scale, Putnam scale, pine-leaf scale, cottonwood scale, locust borer, flat-headed apple-tree borer, shothole borers, bronze birch borer, fruit-tree leaf-roller, cherry slug, grasshoppers, various species of plant lice, pear blight and poplar canker.

Certificates have been issued to the following nurserymen:

C. Bessemer Nursery	Sterling
Boulder Strawberry Gardens	Boulder
Braun, J. G., Nursery	Denver
Broadview Nursery	Arvada
Colorado Gardens	Colorado Springs
Colorado Nursery Co.	Loveland
Columbine Nursery Co.	Denver
Wm. Clark Nursery	Colorado Springs
Denver Nursery Co.	Denver
Denver Wholesale Florist Co.	Denver
Elitch Gardens Co.	Denver
Fort Morgan Nursery (The)	Fort Morgan
Gesterfield, Henry	Monte Viste
Globe Greenhouses	Denver
Grandview Nursery	Wheatridge
Gutheil Park Nursery	Aurora
International Nursery	Denver
Johnson, B. C.	Sterling
S Knudsen	Boulder
Langman, A. R., Nursery	Colorado Springs
Meyer, Fred C., Nursery	Denver

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Northern Colorado Nursery Co.	Fort Collins
Northern Nursery Co.	Denver
Oske, Paul	Aurora
Park Floral Co.	Denver
Patrick Lee & Sons, Nursery	Colorado Springs
Pike's Peak Evergreen & Nursery Co.	Colorado Springs
Pike's Peak Floral Co.	Colorado Springs
Pueblo Floral Co.	Pueblo
Roberts Rose Co.	Denver
Rockmont Nursery	Boulder
Roselawn Cemetery Nursery	Pueblo
Standard Nursery	Greeley
Sutherland Nursery Co.	Boulder
Weld County Nursery	Greeley
Wilmore, W. W., Nursery	Denver
Mathewson & McGuire	Derby

PLANT QUARANTINE

There are cases where the regular inspection work as it is carried on in the State does not afford adequate protection against the introduction or spread of certain insect pests and plant diseases. To make this protection possible certain quarantine regulations have been issued and are being enforced as carefully as possible. These regulations forbid the entrance into the State of products that may be carriers of certain pests, or permits their entrance only after inspection of under certain regulations. Assistance is given the Federal Horticultural Board in the enforcement of the federal quarantines that are in effect against such insects as the European corn borer, Japanese beetle and Gypsy moth. The quarantine enforcement is greatly increasing the amount of inspection work to be done and is very important in the protection of the State against new pests. Since much of this work must be done by the county horticultural inspectors, our protection is lessened by the fact that some counties have not realized its importance and do not provide inspectors. It has been demonstrated without question that carefully enforced regulations are very important in preventing the spread of serious pests. Without regulations the Gypsy moth, for instance, would undoubtedly be over the entire United States, or the European corn borer into the corn belt.

The following is a brief summary of the State quarantines that have been in effect during the year of 1922:

Quarantine No. 1. Potato Tuber Moth:—This forbids the shipping into Colorado of potatoes infested with the potato tuber moth (*Phthorimaea operculella* Zell). This insect is not known to occur in the State. It is a serious pest of potatoes in parts of California and Texas.

Quarantine No. 7. (Amended Jan. 27, 1921.)—Alfalfa Weevil:—Alfalfa hay and other hays of all kinds and cereal straws that have been grown or stored in the states of Utah and Idaho, or in certain counties of the states of Wyoming, Oregon and Nevada, and all shipments of any kind containing any such hays or straws are forbidden entry into Colorado. Alfalfa meal and nursery stock are permitted entry under certain regulations.

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Quarantine No. 8. Black Stem Rust:—The common barberry *(Berberis vulgaris)* and its horticultural varieties are forbidden entry into the State from any sources whatsoever. This order also declares those barberries that are now in the State to be pests harboring a serious disease to grains and grasses and orders their destruction. The barberries are alternate hosts of the black stem rust.

Quarantine No. 10. Alfalfa Weevil:—This forbids the shipping or hauling of any hays and straws out of Delta County and certain parts of Gunnison and Montrose Counties. Under certain regulations alfalfa meal, and straw used for packing purposes may be shipped.

Quarantine No. 11. (Amended April 7, 1922.) White Pine Blister Rust:—This forbids the shipping into Colorado of all five-leafed pines and all varieties of gooseberries and currants from all states east of and including the states of Minnesota, Iowa, Missouri, Arkansas and Louisiana, and from the state of Washington.

BARBERRY ERADICATION

The campaign for the eradication of barberry has been continued during the year. State Entomologist Quarantine No. 8 declares the common barberry *(Berberis vulgaris)* and its horticultural varieties a menace on account of harboring the black stem rust, a serious disease of grains and grasses, and orders their destruction. The work of locating these plants and seeing that they are destroyed has been done almost entirely by the Bureau of Plant Industry, U. S. Department of Agriculture, in cooperation with the Botany Department of the Colorado Agricultural College. Mr. Ernest A. Lungren, state leader in the eradication campaign, makes the following report on the year's activities:

"The report of the barberry eradication campaign covering a five-year period, 1918-22, shows a record of 24,000 common barberry bushes found on 1,642 properties. Every bush has been destroyed on all but three of these 1,642 properties. During the past season an original survey was made of parts of 22 counties. This area had not been completed in the previous farm-to-farm survey. An intensive re-survey was made of the area previously surveyed in 40 counties.

"The past season's results show that this shrub is very hardy and sprouts readily unless very careful methods are used in digging. Experiments with crushed rock salt have proved it to be an effective chemical for killing common barberry bushes. The application of 10 pounds of rock salt piled into the crown of a medium-sized bush will kill it. Smaller amounts of salt may be used for sprouts or on smaller bushes but not less than 5 pounds should be applied.

"Work for the coming spring will be devoted largely to intensive re-survey in the southern part of the State. Reports of the presence of stem rust will be investigated with a view to locating barberry bushes from which the rust may have spread. Through the location and the destruction of all remaining common barberry bushes, sprouts, and seedlings, it is estimated that it will not be long before Colorado is

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entirely free from this bush which is responsible for the early spread of stem rust."

WESTERN PLANT QUARANTINE BOARD

The annual meeting of this board was held in Sacramento, California, in June with representatives present from British Columbia, Lower California and eight of the eleven Western States that comprise the territory covered by the board. Three members of the Federal Horticultural Board, Washington, D. C., and representatives of the U. S. Post Office Department were in attendance as well as a number of delegates representing various nurserymen's associations, transportation companies and shipping organizations. Two days were spent in discussing and harmonizing the plant inspection and quarantine work. The points of most importance to Colorado that were discussed were the inspection of parcel post shipments of nursery stock and the alfalfa weevil quarantines. A third day was given to a discussion before the Federal Horticultural Board of the federal quarantines issued on account of the Mediterranean Fruit Fly. Several hundred fruit-growers representing different sections of California were in attendance and took an active part in the discussion. Many felt that a more rigid quarantine was needed to protect against the importation of this pest, which if introduced might almost mean the destruction of the citrus-fruit-growing industry and be a serious menace to the deciduous fruit growing.

These meetings have done a great deal to bring about better co-operation among the various states, transportation officials, shippers and others affected by the plant inspection and quarantine work. The present officers of the Western Plant Quarantine Board are C. A. Park, Salem, Oregon, Chairman; W. H. Wicks, Boise, Idaho, Vice-Chairman, and Lee A. Strong, Sacramento, California, Secretary and Treasurer.

NOTES ON INSECT AND MITE PESTS

COTTONY MAPLE SCALE, *Pulvinaria vitis L.*

The results obtained by the City of Colorado Springs during the past season in combating the cottony maple scale show what can be accomplished through a well-organized campaign for its control. Trees that were in a very weakened or dying condition are beginning to revive after a thorough spraying greatly reduced the scale infestation. Another season's work should place this pest under control in this city where it has been so injurious for a number of years.

The scale is quite numerous in the outskirts of Denver, in Pueblo and in Littleton, while some can be found in most all sections of the State. In the Denver section one of the lady beetles, *Chilocorus bivulneratus,* has been very active in destroying the scale. In one nursery where the scale had been very numerous the year before, this beetle

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was so numerous that few scales remained in the fall. Many limbs were lined with pupa skins of the beetles.

SAN JOSE SCALE, *Aspidiotus perniciosus* COMST.

As far as is known the infestations in Mesa and Delta counties are the only two that exist in the State. We are fortunate that no nurseries exist in these immediate sections. The infestation in Mesa county now extends over almost the entire fruit section. Contrary to the experience reported by other states, it is not proving as injurious to peaches as to apples, nor have the lime-sulphur sprays failed to give satisfactory control when applied properly. In this section the mortality during the past winter was very high, in many cases equaling the kill obtained by an ordinary application of spray. This coupled with a very active campaign of spraying has placed the scale under better control than for a number of years.

In Delta County the acreage infested is quite small, representing only a few orchards. Results obtained in the spraying campaign one year ago were not satisfactory, largely on account of a lack of attention to thoroughness in spraying. Since then a pest district has been organized under the Pest Inspection Act and closer supervision will be given.

HOWARD SCALE, *Aspidiotus howardi* COCKERELL

This scale insect causes a greater loss to the pear growers than does San Jose. While the infestations seldom become serious enough to greatly injure the trees, the habit of the insect of migrating to the fruit and the pitting caused by their feeding is responsible for a great deal of fruit being reduced in grade. An infestation that is hardly noticeable on the trees may result in 25 or 50 percent of the fruit being pitted. It is quite general in apple orchards but attracts little attention.

PUTNAM SCALE, *Aspidiotus ancylus* PUTNAM

The Putnam scale is quite general over the State. In the Arkansas Valley, some injury is being done to the cherry orchards. Trees are often found badly incrusted and their vitality lowered. One planting of currants near Canon City is very badly infested. It does not migrate to the fruit of the apple and pear, so is seldom noticed on these fruits, even though it is quite common. A considerable infestation exists in one small nursery on elm and maple trees.

OYSTER SHELL SCALE, *Lepidosaphes ulmi* LINNAEUS

The oyster shell scale is quite general over the State on a variety of shade trees and ornamental shrubs. It is proving especially injurious to ash trees and purple lilacs. We have never taken it on fruit trees. In some of the cities, especially Denver and Fort Collins, many valuable ash trees are being lost. The ash, under our conditions at least, does not have the power to revive after serious injury by this pest has occurred.

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EUROPEAN ELM SCALE, *Gossyparia spuria* MODEER

Since elms are among our most valuable and generally planted shade trees, this insect which is now found in most sections, is causing a great deal of concern. Few trees are being killed but many are made very unsightly. The fact that it occurs in some of the nurseries has probably been responsible for its rapid spread even though careful cleanup campaigns have been inaugurated and fumigation required.

EUROPEAN FRUIT LECANIUM, *Lecanium comi* BOUCHE

Fig. 1. European Fruit Lecanium, *Lecanium comi* Bouche, on native oak.

On June 24, Mr. D. M. Andrews sent us some twigs from the native oak taken at Boulder, which were heavily infested with a scale insect. These were later determined by G. F. Ferris as *Lecanium comi* Bouche. Mr. Andrews reported several small trees quite heavily infested. This is the first record of the occurrence of this scale in the State, so it is of considerable importance since is has proved quite a serious pest to fruit trees in some states. It is commonly known as the European Fruit Lecanium and is known to attack practically all species of deciduous trees. The insects were in the egg stage under the large brown scales when they were received June 25, but the small lice began to hatch June 28 and continued hatching over a five-day period. (See Fig. 1).

Aspidiotus æsculi JOHNSON

Specimens of this scale were secured from Boulder on twigs of the butternut, *Juglans cinrea* Linn. This seems to be a new record for this scale on this host in Colorado. Buckeye and black walnut are reported as the favorite hosts in other sections, but it has been taken on oak, willow and pear. The scale was determined by G. F. Ferris.

Lecaniodiospis pruinosa HUNTER

During the early winter, Captain F. W. F. Wieber, Commanding Officer, U. S. Naval Hospital, Fort Lyon, Colo., sent us several cottonwood limbs heavily infested with a large scale, with the report that these trees at the hospital were being seriously injured. Later, Mr. H. E. Mason, Horticultural Inspector for Otero County, sent the same scale from Rocky Ford. An investigation at Rocky Ford revealed a

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heavy infestation on a number of cottonwood and American elm trees. The vitality of the trees had been reduced and dead limbs were appearing. The scales were identified by Mr. Harold Morrison, U. S. Bureau of Entomology, as *Lecaniodiaspis pruinosa* Hunter. This is the first record of the occurrence of this species in the State. (See Fig. 2).

Fig. 2 *Lecaniodiaspis pruinosa* Hunter, on cottonwood. Taken at Fort Lyon, Colorado.

Neoclytus caprea SAY

On October 7, 1921, the junior author collected several specimens of this species from the split trunks of recently cut ash trees in the Roselawn Cemetery, Pueblo, Colorado. Our identification was verified by W. S. Fisher, U. S. Bureau of Entomology. The trees, which had been cut on account of their dying condition, had been literally honeycombed by the borers. Adults were numerous on the logs and could be found within the burrows by splitting most any part of the trunk. Since this insect is thought to attack only trees weakened by some other cause, it is very likely that they are not primarily responsible for the loss of these ash.

Saperda moesta LEC.

On December 31, 1921, Mr. J. M. Wildeboor of Delta, Colorado, sent us a number of twigs from his North Carolina poplars that were infested with a larvae, with a report that the twigs on his nine-year-old trees were being killer back each season. The infested twigs were of the past season's growth. The feeding of the larvae caused a gall or an enlargement of the twigs to about double their natural diameter and about one inch in length. The material was placed in the insectary and on June, 1922, several adults emerged which were determined as one of the "longhorned" borers, *Saperda moesta* Lec. They apparently make their burrows almost to the surface before pupation and upon emergence the adults make an opening to the surface leaving a clean-cut hole between one-sixteenth and one-eighth of an inch in diameter. (See Fig. 3).

THE RED SPIDER, *Tetranychus telarius* LINN.

The past season has been rather unusual for the occurrence of this pest, probably largely on account of the precipitation being considerably below normal and the temperature somewhat above, es-

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Fig. 3. Twigs from a poplar tree showing galls made by the larvae of a "longhorned" beetle, *Saperda moesta* Lec. The small hole was made by the adult beetle after it pupated within the gall.

pecially throughout the eastern part of the State. The greatest loss occurred in the Arkansas Valley where a considerable acreage of gooseberries is grown for canning purposes. The infestation was so severe in some fields that many bushes were largely defoliated before the fruit was harvested. It was reported that in some cases the fruit did not mature properly and was not harvested. Little was done to control the pest. Considerable injury was done at Littleton and Denver to gooseberries, currants, and shade trees. In Denver, the injury to elm, maple and linden was quite severe. Some injury usually occurs in the red raspberry plantings of northern Colorado every year, but it has been much worse the past season.

The mite is usually common throughout the orchard section of the Western Slope. The injury this season has been somewhat more than common and several reports came of rather severe injury to corn in Delta and Montrose counties.

BROWN MITE OR CLOVER MITE, *Byrobia pratensis* GAR.

In the orchard sections this mite is more common than the red spider and often does considerable injury, especially to peach, apricot and pear trees. It is a source of annoyance to housewives during the fall and warm days of the winter on account of its habit of getting into the house. A number of requests are received each year for information as to how they may be kept out of the houses.

BLISTER MITE, *Eriophyes pyri* PGST.

Reports are received each year from all sections of the State in which apples are grown as to the identity and control of the pear-leaf blister mite. In some cases where control methods are not followed the injury is rather severe to certain varieties. It is seldom reported on the pear.

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CYCLAMEN MITE, *Tarsonemus pallidus* BANKS

An occasional complaint comes to us of injury to the cyclamen by this mite, but we have never had a report of serious injury to other plants until this season when a local florist called our attention to an injured condition of several hundred variegated geranium plants which were being grown for spring planting. They were found to be very heavily infested with this mite. The grower chose to destroy the plants rather than attempt control. Our identification of the species was verified by Dr. H. E. Ewing, U. S. National Museum.

BULB MITE, *Phizoglyphus hyacinthi* BOISD.

Mr. O. B. Robbins of Robbins & Sons, Florists, Loveland, Colo., brought to the laboratory March 10, 1922, several Easter lily plants grown from imported bulbs, which were very badly stunted apparently as a result of a very serious attack of the above mite. The plants were not over six or eight inches in height with small buds and blossoms. Some of the stems and bulbs were hollow and almost entirely eaten and rotted off. (See Fig. 4.) In the decaying portions mites were present in large numbers. Among the bulb scales there were found many small brown spots where the injury seemed to be starting and always in these spots there was one or more mites present. (See Fig. 5.) A visit to the greenhouses a few days later convinced us that the entire plant was a loss and the mite was responsible. The mites were deter-

Fig. 4.—Easter lily plant showing the stunted growth caused by the bulb mite, *Rhizoglyphus hyacinthi* Boisd. Note the hollow and discolored stem and injured bulb.

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mined by Dr. H. F. Ewing, of the National Museum, as the above species.

This is the first report of serious injury from this mite in the State, although it is reported as quite common in countries where the bulbs are grown, and is undoubtedly imported on many shipments.

BOX ELDER BUG, *Septocoris trivittatus* SAY.

A number of requests are received each year for information on this insect, not on account of its injury, but because of the annoyance caused by it crawling into houses or collecting upon buildings and walks.

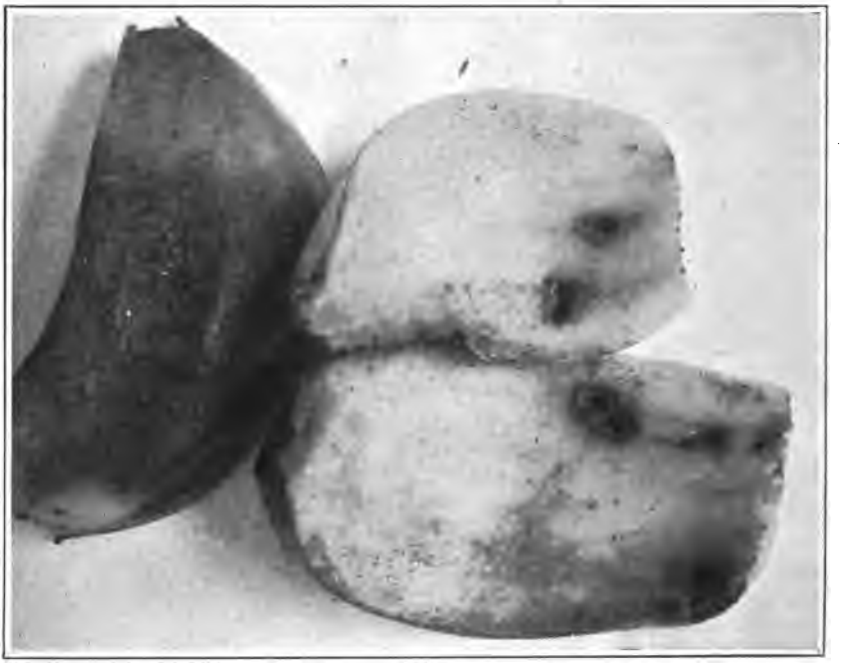

Fig. 5. Scales from an Easter lily bulb showing injury from the bulb mite before decay has set in. A number of mites were in each hole.

BEDBUG, *Cimex lectularia* LINN.

As a rule, we do not learn of the presence of this unpleasant pest only as a housekeeper, as a last resort, writes for control methods. Nevertheless, a number of letters are received each year.

WOOLY APPLE APHIS, *Eriosoma lanigera* HAUSM

This aphis exists in all sections where apples are grown, and in many cases, does considerable damage. It often receives the blame for many conditions that exist in orchards for which it is not responsible.

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ROSY APPLE APHIS, *Aphis sorbi* KALT

The spread of the rosy apple aphis in the fruit sections of the Western Slope has been rather rapid. The injury during 1922 was much less than during the previous year. In most cases it has hardly been noticeable enough to attract the attention of orchardists. It has never been taken in the eastern part of the State.

SPRING GRAIN-APHIS OR "GREEN BUG", *Toxoptera graminum* ROND

A very sudden and severe attack of this aphis occurred in the wheat-growing sections of the southeastern counties of the State. In many cases the loss was almost complete and no doubt totaled many thousand bushels of grain.

MELON APHIS, *Aphis gossypii* GLOV.

As usual, this has been an important factor in the melon-cantaloupe-and cucumber-growing sections. The injury has not been as great as during 1920 when this pest in conjunction with the melon rust caused probably a fifty percent loss in the Arkansas Valley, the principal producing section.

PEACH TWIG BORER, *Anarsia lineatella* ZELL

The peach twig borer causes a considerable annual loss in the peach sections. This loss is largely from wormy fruit at harvest time. This loss was not so noticeable this year on account of much fruit remaining in the orchards for lack of markets and transportation facilities.

FRUIT TREE LEAF-ROLLER, *Archips argyrospila* WALK.

A very welcome let-up in the activities of this pest has occurred in Fremont County where so much damage has resulted over a period of 10 or 12 years. Only a small percent of the growers sprayed this past spring and the section as a whole has produced one of the best crops in years. Very few egg masses are found on the trees and it is felt that spraying need not be a general practice another year.

WIREWORMS (Larvae of *Elateridae)*

We have little information in regard to the exact species of wireworms that occur in the State and the extent of their injury. Their importance in the high-altitude head-lettuce-growing region has been brought forcibly to our attention by many letters from all these regions. The injury reported has ranged from 2 to 15 percent of the crop planted. Their injury to potatoes is quite common in the valley as well as high-altitude sections.

FALSE WIREWORMS (Larvae of *Eleodes* Beetles)

These larvae which are commonly taken for the true wireworms, have been very injurious in the non-irrigated winter-wheat-growing sections in the northeastern counties of the State. The extreme drouth condition during the past fall has undoubtedly made this appear much

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worse than it really has been. In many cases considerable seed was destroyed before germination took place. The only adults reared from material sent to the laboratory were *Eleodes extricata* Say, but undoubtedly others are involved.

MEXICAN BEAN-BEETLE, *Epilachna corrupta* MULS.

This destructive pest has not been as injurious during the past year as usual. A fair crop of early snap beans was produced in Fort Collins and Denver sections without control work, where ordinarily few can be grown. The mortality of the over-wintering bettles was greater than usual. The infested territory has not been materially increased on the eastern slope of the mountain range. It is limited to the small mountain valleys and a narrow strip of country along the eastern foothills not over 20 or 30 miles in width,extending the entire length of the State north and south. There has been considerable spread northward on the Western Slope, especially in Montrose and Delta counties. These entire counties have become infested during the last 3 or 4 years. Since beans are an important crop in these counties, the infestation is causing a great deal of concern. A few life-history studies have been carried out in the insectary at Fort Collins and some control methods tested in the field. These tests consisted mostly of a comparison of the relative value of the arsenical poisons applied in the liquid and dust form. The dusts have not been as effective as the liquids.

LADY BEETLE, *Hippodamia convergens* GUER.

In the past years we have had infrequent reports of lady beetles collecting in the foothills and mountains for hibernation but never has this been observed to be so general as this last fall, unless it was during the year of 1916. Authentic reports of large numbers being found in several places near Colorado Springs and Denver were received. Scouting trips to the foothills west of Fort Collins revealed their presence on the tops of most of the higher foothills. One interesting point in connection with their occurrence was the early date of appearance. Large numbers were reported in the Denver mountain parks at an altitude of 7500 feet, July 4. During July, we found them in great numbers on Mt. Vernon just west of Fort Collins, at an altitude of approximately 7000 feet. Their favorite places for collection, as obobserved on Mt. Vernon and Horsetooth, were crevices and sides of rocks, in the grass, twigs and pine needles at the base of shrubs, and in the pine needles under trees. It was estimated that several gallons occurred in some of the larger clusters, while again only a few beetles might be found at the base of a bunch of grass or a small shrub. The reports would indicate that the hibernation may occur at altitudes ranging from 6,000 feet to snow line or higher. *Hippodamia convergens* Guer. was the species in predominance.

In 1921 Miss Mariam A. Palmer took one speciment of *Coccinella 9-notata* and noted several *Hippodamia convergens* on the top of Long's Peak at an altitude of 14,255 feet that were apparently seeking hiber-

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nating places. Mr. F. C. Hottes found *Coccinella 9-notata* and *Hippodamia sinuata* in considerable numbers at the base of a yucca plant at an altitude of about 6000 feet.

CABBAGE ROOT MAGGOT, *Phorbia brassicae* BOUCHE

The first authentic reports of the occurrence of this insect in the State were received this year. Mr. K. Ikeda, of Denver, sent in infested plants on May 16, with a report that considerable damage was being done. A few days later Mr. K. A. McCaskill, County Agricultural Agent of Jefferson County, sent additional specimens. His letter stated that the infestation was so bad in some sections that little early cabbage would be raised. He said that every plant in four fields visited on May 28 was infested.

SEED CORN MAGGOT, *Phorbia fuscieps* ZETT.

Several complaints were received during the year of injury to beans by this maggot. Probably the most serious injury was reported from Grand Junction by Mr. W. P. Yetter, Jr. In several fields the stand of beans was materially reduced.

CODLING MOTH, *Carpocapsa pomonella* LINN

The codling moth is the most difficult insect in the State to keep in touch with in such a way that accurate information can be secured to guide the control work. It, in its development, is very responsive to temperature and moisture conditions and the great variety of conditions given by our different altitudes, mountain valleys and plains sections makes its study a different problem in each fruit-growing section. In order to assist the growers as much as possible, field stations have been maintained at Grand Junction and Paonia, Colorado, where careful life-history studies have been carried through. The former station has been in charge of Mr. W. P. Yetter, Jr., assisted by Mr. H. L. Sweetman, and the latter in charge of Mr. J. H. Newton, assisted by J. L. Hamilton. In addition, sufficient studies were made at Austin to correlate the conditions with those of Paonia. Through the cooperation of Mr. Irving Schaefer, of the Montrose High School, very complete studies were made in the principal fruit section of Montrose County. Through the aid of these studies, the spraying dates for each locality were determined far enough in advance to be gotten to all growers through the local papers and by telephone.

A number of other studies have been carried on in an effort to secure new information on control methods. Chief among these were a comparison of the relative value of spraying and dusting by Mr. Newton; efficiency of traps to catch adult moths, by Messrs. Newton and Yetter; the relation of the rate of growth of apples to spraying dates and methods by Mr. Yetter, and the value of ovacides by George M. List and J. L. Hoerner.

In northern Colorado, Fremont County, and the lower Arkansas Valley, an unusually heavy crop of apples was produced. This followed

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almost a complete crop failure of the previous year which had greatly reduced the codling-moth infestation. As a result the crop was kept very free from codling-moth injury with little effort. Many made only one or two applications of spray where four are usually required.

Delta and Montrose counties produced a heavy crop with codling moth conditions about normal. A closer attention to the making of the applications of spray on the dates recommended gave better control than usual. In the Austin section of Delta County, there were indications of a considerable third brood. The appearance of these late worms made a sixth spray advisable where only five made the usual schedule. Those that failed to make this extra application as recommended suffered a rather heavy loss late in the season.

The following extracts from the summary made by Mr. Yetter of the work and conditions in Mesa County give the codling-moth conditions of that section where they are so unusually numerous and difficult to control:

"The 1921 season for the apple and pear growers of Mesa County was a good one from the standpoint of codling-moth control. This was due mainly to three things: the good crop, the clean-up campaign and the favorable weather conditions.

"With the same conditions prevailing for 1922, the 1922 season should have been a good one also, but the spring was late, cold and wet, and most of the apple bloom fell leaving a very light crop. The growers became negligent and the worms soon got a strong foothold, and from then on they were never headed off and the 1922 crop was almost totally ruined.

"The crop was about one-fifth as large as the 1921 crop and so the injury was more apparent and the control was harder to secure. The season was extremely hot and dry, which was an ideal condition for the codling-moth to develop in all of its stages. Most of the trees were scraped and banded but with the light crop on hand, low prices being predicted and a heavy infestation rapidly coming on, the growers began to lose heart and the worms soon had them on the run.

"This year a field laboratory was set up on Mr. A. C. Newton's place on First Fruitridge, with Mr. H. L. Sweetman doing life-history work, and the spray dates were determined from the reliable data thus made available.

"The spray schedule for 1922 was as follows: Calyx, May 12; 1st cover, June 3-4; 2d cover, June 11; 3d cover, June 22; 4th cover, July 9; 5th cover, July 21; 6th cover,Aug. 5; 7th cover, Aug. 20.

"While the apple crop was small, the pear crop was a large one but during the period from July 21 to August 15, the worms became so numerous that they ruined about 175 carloads of pears in three weeks. In most any orchard you went into the ground was covered with pears and apples."

FLEA BEETLES

By J. L. HOERNER.—Losses this year from "worm tracks" of the flea beetles on the potatoes of Weld County have been slightly less than last year and are estimated by the inspectors of the Colorado Division of Markets as close to $100,000.00.

The species most prevalent was *Epitrix cucumeris*. *Systena taeniata* was found to be more numerous in some fields and may be responsible for some of the injury that occurred.

Life-history work on *E. cucumeris* has been carried through the

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summer along with preliminary control measures. All attempts to rear *S. taeniata* on potatoes failed.

Other *Halticini* collected are:

Disonycha triangularis Say.
Systena hudsonias Forst
Phyllotreta vittata Fabr. *
Psylloides convexiar Lec. *
Disonycha carolinana Fabr.
Phyllotreta pusilla Horn.
Phyllotreta aeneicollis var Cr. *
Phyllotreta oregonensis Cr. *
Epitrix parvula Fabr.
Glyptina nivalis Horn *
Glyptina sp. *

* Determined by F. A. Chittenden, Bureau of Entomology, U. S. Department of Agr.

YELLOW-PINE TENT-CATERPILLAR

Euschausia ingens HY. ED.

By C. P. GILLETTE

Fig. 6. Tent of pine web-worm on a limb of yellow pine showing work of the caterpillar.

The beautiful moth of this species is occasionally taken in and near the foothills in the vicinity of Fort Collins, Colo., but the hairy caterpillars are rarely seen. A larva taken in Rist Canon near Fort Collins on a rose bush by Mr. C. F. Baker, May 28, 1892, was fed upon leaves of red clover, which it ate freely, and pupated June 20th. The moth appeared July 13th.

On June 7, 1905. Mr. O. G. Babcock took tents of this tent-caterpillar from small trees of yellow pine in the Fort Collins foothills. The tents were rather dense much as in the case of the apple-tree tent-caterpillar, *Malacosoma americana*. Several small branches of the pine had been almost completely

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stripped of needles (See Fig 6), by the caterpillars. The moths hatched from July 12 to July 24. (See Fig 7).

Fig. 7. Pine web-worm, *Euschausia ingens*, Hy. Ed. Female moth, natural size.

During the month of June, 1922, several complaints came to the office of the State Entomologist that some insect was eating the needles from the small yellow pine trees in the foothills of Fort Collins and doing much damage to the trees. Several of the tents of this insect were brought to the insectary from these infested trees and a large number of moths and parasites reared by Mr. J. L. Hoerner. These moths emeged from July 10 to July 21.

During the month of June, 1922, several complaints came to the office of the State Entomologist that some insect was eating the needles from the small yellow-pine trees in the foothills northeast of Fort Collins and doing much damage to the trees. Several of the tents of this insect were brought to the insectary from these infested trees and a large number of moths and parasites reared by Mr. J. L. Hoerner. These moths emerged from July 10 to July 21.

The caterpillars leave the nests when fully grown and seek secluded places in which to spin their cocoons which are dark brown in color because of the hairs of the caterpillar which are worked into the silk of the cocoon. The tents should be cut out and burned or otherwise destroyed as soon as found whenever this insect becomes sufficiently numerous to do serious harm. The worms could doubtless be destroyed also by means of an arsenical spray.

ALFALFA WEEVIL

Phytonomus posticus

PROGRESS REPORT FOR 1922, By J. H. NEWTON

The year of 1922 marks the fifth year since the discovery of alfalfa weevil in Colorado. The office of the State Entomologist, through its field station at Paonia, has gathered first-hand information of the dissemination of weevil from the original point of infestation. Thorough scout work has been carried on each season, beginning within the known area of infestation and working outward to determine the most recent spread to adjacent territory.

HISTORY OF DISSEMINATION IN COLORADO

At the time of discovery in 1917, it was impossible to determine the exact area infested other than was indicated by a limited amount of scout work. No weevil could be found in the fields west of the town of Paonia, while to the east, the infested territory extended up the narrow valleys for five and nine miles, with an average width of one mile, the maximum being two to three miles.

The first thorough scout work was completed in 1918 with the

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result that new fields were located three to four miles further west and some ten or twelve miles east of that known in 1917, but judging from the degree of infestation some of the latter were not newly infested areas.

In 1919 two new points of infestation were found, one on Redlands Mesa in Delta County and another on Spring Creek Mesa, Montrose County, near the town of Montrose. Both of these points were entirely isolated from the original infestation, the former being ten miles distant from the previous known infestation and so heavily infested that its original occurrence is believed to pre-date or equal that of the first discovery in Colorado. At Montrose the numbers of weevil were very scarce indicating a comparatively new infestation.

By 1920 the Montrose area had increased six hundred percent, while in Delta County the spread continued westward to the city of Delta. This left the Delta and Montrose districts separated by an uninfested strip only fifteen miles wide, which in 1921 narrowed to six miles at the narrowest place. The most rapid spread in 1921 was from Delta County southward on the east side of the Uncompahgre River. To the southwest of the town of Delta the spread was not a mile beyond the known area of 1920 even though the alfalfa fields are continuous.

SEASON OF 1922

The season of 1922 proved to be an exception to the rule in more ways than one. Briefly stated, it may be said that there was less weevil, less injury, less spread and more parasites than ever before. Only a limited number of fields had enough injury to warrant control work, while the average loss was only 50 per cent as great as the preceding year.

This deficiency is probably the product of many factors, which have not been proved, correlated or discovered in the data at hand. In working over the problem the following possible factors suggest themselves:

1. Parasitism.
2. Fluctuation of temperatures during the season of egg laying.
3. Mortality of adults during hibernation.
4. Predacious enemies.

Parasitism of the weevil is the only factor upon which data can be presented to prove its increase over preceding years and it alone is not thought to be great enough to account for the decrease in 1922.

No weevil parasites, *B. curculionis,* could be found in Colorado in 1917, but were introduced the following year from Utah. Parasites were recovered from the field in the fall of 1918, thus proving that they had become established. Further introductions were made from Utah in 1919, resulting in the firm establishment of *Bathyplectes curculionis* in Colorado. Since their introduction, the parasites have rapidly spread over the entire infested territory of the State so they have been found wherever the weevil is known. Within the short period of four years parasitism has increased from nothing to as high

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as fifty per cent in certain localities. As stated above, parasitism is without doubt an important factor, but is not considered entirely responsible for the deficiency of weevil injury in Colorado.

It is interesting to note that Mr. G. I. Reeves, of the U. S. Bureau of Entomology, located at Salt Lake City, Utah, reports that there was not enough weevil injury in Utah to warrant control experiments.

Mr. C. C. Wakeland of the Idaho Experiment Station reports a decrease of weevil injury in eastern Idaho similar to that experienced in Utah and Colorado; whereas in western Idaho weevil injury was extremely severe.

RESULTS OF SCOUTING IN 1922

Only two places were found where the weevil had spread beyond the former known boundary. The east boundary near Montrose moved two miles eastward, while on Coal Creek new fields were found 1½ miles further down the Creek to the north. On North Mesa, between Montrose and Olathe, weevil were found which connected the Delta and Montrose infestation thus warranting the previous year's quarantine which included all the valley east of the Uncompahgre River.

For the first time in the history of weevil scouting in Colorado, two or three instances were met with in which weevil could not be swept in fields which showed a slight infestation the preceding year. Such cases occurred on the outlying boundaries. Although this came as a surprise, yet it could have been expected as it is in direct accord with the decrease of weevil population in all parts of the infested district. Previously, there had never been a time when a second year of scouting did not reveal considerable increase over the preceding season in a given locality of new infestation. There was no spread south or west on California Mesa from the first point of infestation located just west of the city of Delta. Although this point of infestation has been known since 1920, the weevil have not disseminated over two miles to the southwest in two seasons, under conditions most favorable for dissemination.

QUARANTINES OF 1922

Only twelve sections of new territory were quarantined, constituting the smallest increase of area any time since the establishment of the quarantine in 1917. The new territory includes Sections 31, 32, 33, 34 of T. 50 N., R. 10 West, and Sections 18, 19, 20, 21, 29, 30, 31 and 32, T. 49 N., R. 8 W.

CONTROL EXPERIMENTS

Endeavoring to follow the line of work attempted in 1921, three fields were selected for experimental work upon the use of dust spray in comparison with liquid spray for weevil control. The limited size of the fields in the Paonia district is ever a handicap for the best experimental work. Only one of the three fields chosen for work in 1922 proved to be worth while and even it was too small for dusting as there was considerable drift from one plot to another. The liquid

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Fig. 8. Niagara Crop Duster equipped for alfalfa dusting.

spray can be positively controlled with almost no drift from one plot to another.

Larger-sized plots would not only reduce drift to a minimum but at the same time establish more uniformly representative plots of each field.

The experimental field of 1922 consisted of six one-acre plots, four of which were dusted, one sprayed and an untreated check. Treatment of the plots was as follows:

Fig. 9. Applying lead arsenate in dust form for weevil control.

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Plot	Treatment	Material	Amount	Poison per Acre	Percent Killed Using Check Plot for Comparison
B		50% $CaAs_2O_3$			
	Dust	50% Hydrated Lime	8 lbs.	4 lbs.	60.39
C	Sprayed	2 lbs. $CaAs_2O_3$	100 gal		
		per 100 gal. H_2O	per acre	2 lbs.	61.47
D	Dust	50% $CaAs_2O_3$			
		50% Hydrated Lime	4 lbs.	2 lbs.	64.48
E	Dust	Pure $CaAs_2O_3$	2.5 lbs.	2.5 lbs.	54.36
F	Dust	Pure $CaAs_2O_3$	4.17 lbs.	4.17 lbs.	65.90

The results are inconsistent as shown by the above table, yet comparing Plot C with D the dust gave as good control as the liquid. Plot E fell below the average, due probably to the small amount of material which could not be handled effectively by the dusting machine. Increased amounts of dust and poison did not increase the effectiveness of the material.

Taking the growth of the second crop as an indication of control results in killing the larvae on the first crop so that they will not retard the second crop, it may be stated that there was no difference between the sprayed and dusted portion nor between any relative dusted portions, whereas, the check plot was fully ten days late in producing return growth.

The control work for the season is not satisfactory and can only be taken as an indication of the possibilities of dusting for weevil control.

Through the courtesy of the Niagara Sprayer Company of Middleport, N. Y., a "Niagara Crop Duster" has been loaned for the work. A special dust boom and mechanical raising and lowering-device has been constructed and attached by the Paonia station. For illustration of the distributing device and machine in operation, see Figures 8 and 9. The "dust boom" is not entirely satisfactory, but it is hoped that this may be improved during another season.

GRASSHOPPER CONTROL

By C. L. Corkins

The year 1922 was characterized by numerous small, local outbreaks, scattered over many of the agricultural sections of the State. These were taken care of largely by correspondence from this office, with the assistance of the county extension agents, and by furnishing the farmers so affected with the prepared grasshopper bait sold at cost by the office of the State Entomologist, the Colorado Agricultural College and the Extension Service, cooperating. Approximately 2,000 cans of Colorado Poison Grasshopper Paste were sold, this being sufficient to mix 200,000 pounds of bran and treat 30,000 acres. It is impossible to even estimate the saving this brought to our farmers in

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actual crop protection. In addition, it has helped to check the rise of larger infestations from smaller outbreaks.

The two counties putting on the largest campaigns during the year were Morgan and Mesa.

MORGAN COUNTY CAMPAIGN

Being warned of the possibility of a large outbreak by a small invasion last season, the county commissioners were influenced by this office to hire a county pest inspector for the emergency and put up a revolving fund for the purchase of poison supplies to have on hand to sell to the farmers. Mr. R. H. Sims was the very able county pest inspector appointed, and to him belongs great credit for the manner in which the campaign was conducted.

The species of locust concerned was *Melanoplus bivittatus* Say. Hence the problem was one which more or less affected each farmer individually. The hoppers hatched mostly in alfalfa fields, along ditch banks and roadsides. Little migration took place except after the first crop of alfalfa was cut. At this time, the county pest inspector was kept busy seeing that negligent farmers poisoned their hoppers and that non-resident land was treated.

The report of the county pest inspector gives the following figures, which are indeed conservative:

Total number of acres treated	15,000
Value of crops per acre on this area	15.00
Total value of crops on this area	$225,000.00
Percent saved which hoppers would have destroyed	25%
Value of harvest saved by campaign	$ 56,250.00
Cost of materials used in campaign	7,500.00
Total saving	$48,750.00

MESA COUNTY CAMPAIGN

The campaign in Mesa County in many ways resembled the one in Morgan County. The same species of grasshoppers was concerned, about the same amount of acreage affected, and similar crops attacked. However, due to the financial condition of the farmers, it was necessary to obtain some outside financial assistance. Through the efforts of County Extension Agent L. P. McCann, the necessary funds were furnished by the County Commissioners, the Water Users' Association, the Great Western Sugar Company and the U. S. Reclamation Service, cooperating.

With the financial support assured, the next step was to instruct and organize the farmers for actual control measures. This was done by the office of the State Entomologist, with the assistance of the county extension agent.

Mr. McCann's report summarizes the results of this campaign:

"Four communities were included in this work, and a total of 289 farmers cooperated. 15,895 acres of land were treated. The campaign

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resulted in an estimated saving of $39,739.50, which is very conservative. This estimate is based on the actual damage done by the grasshoppers in 1921, when very little was attempted in the way of control."

MISCELLANEOUS INFESTATIONS

Smaller outbreaks to which this office gave attention occurred in the following counties, listed in the order of the importance of the invasion: Logan, Otero, Jefferson, Costilla, Conejos, Delta, Saguache, Huerfano, Pueblo, El Paso, Lincoln, Yuma and Washington.

The grasshopper situation in the foothill pasture-lands in Larimer County became even more serious this year than during the past season. Many thousands of acres of pasture intended for late fall and winter feed were completely ruined. The cattlemen are greatly alarmed and are asking for a means of control which will be practical on land of such low productive value per acre. Our experimental work to date indicates that the best formula for this purpose is as follows:

COLORADO GRASSHOPPER BAIT NO. 15.

Sawdust	2 bushels
Bran (free of shorts)	50 lbs.
Sodium arsenite (8 lbs. As_2O_3 per gal.)	1 pint
Salt	5 lbs.
Sugar beet refuse molasses	2 gallons
Amyl acetate or banana oil (Tech. No. 1)	3 oz.
Water	10 to 12 gallons

With sawdust and sugar-beet refuse molasses obtainable free of charge the cost of other materials per acre for one treatment will vary from 8 to 10 cents. Labor will double the expense, making the actual expense 16 to 20 cents per acre. Usually one treatment is sufficient on pasture lands.

An outbreak of locusts occurred in the truck gardens of Adams County, which was handled entirely by County Extension Agent J. T. Robertson. His report follows:

"The west end of this county is largely composed of garden and truck farmers of small acreage. In previous years, much damage has been done by grasshoppers and there had been no concerted action to get rid of them. This year, the small farmers were instructed to inform the county extension agent, just as soon as the first grasshoppers put in their appearance. A number of them did this, and, as a result, the county agent held meetings in the communities affected and instructed them how to mix and spread the poison to get rid of the pests before much damage had been done to the crops. As a result of this work, about 1500 acres of garden and truck farms were treated, in which 7500 pounds of poison were used at a total cost per acre of 30 cents, or $450.00. This cost, however, is exclusive of the cost of the labor involved. I have had the saving estimated all the way from five to ten dollars per acre, which would be from $7500.00 to $15,000."

DESTRUCTION OF FALL WHEAT

Many inquiries for means of grasshopper control came in during the summer and fall from various sections of eastern Colorado, as a

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result of injury to winter wheat. 'Hoppers which were not numerous enough to do appreciable damage to the prairie grasses, moved in from these areas on to the winter wheat just as it was coming up. Consequently, a small infestation would do considerable damage by eating in around the edges of the fields. The county most seriously affected in this way was Yuma. Here we held an educational meeting attended by 250 farmers. Ordinary control methods proved effective in preventing this sort of injury.

MORMON CRICKET INVASION

A serious invasion of the Mormon Cricket occurred in Moffat County from Price Creek on the east, to the State line on the west, extending to the county line on the south and the Bear River on the north. Before the end of the season, the migrations had extended the infestation south on the Strawberry watershed several miles into Rio Blanco County, and eastward beyond Juniper Mountain.

In the Price Creek section, a united effort to control the pest was put forth by the residents, with some financial assistance from the conuty commissioners of Moffat County and the business men of Meeker. As a result, many crops were saved, and the residents fully convinced that the formula given in our last report was effective if properly used.

Outside the Price Creek area, there was a loss of crops estimated at from $15,000 to $20,000.

EXPERIMENTAL WORK

The experimental work inaugurated last year for the purpose of obtaining the most efficient grasshopper bait for Colorado conditions has been continued. The outstanding discovery has been that of sodium arsenite as a more efficient poisoning agent than white arsenic and less expensive. The optimum amount of sodium arsenite for grasshopper baits was found to be one pint of the material containing 8 lbs. of white arsenic per gallon, to 100 lbs. of bran. If quick killing is desired, one quart is used. Information regarding this bait will be found in the Colorado Experiment Station Bulletin No. 280, "Sodium Arsenite as a Killing Agent in Grasshopper Baits."

DUST VERSUS SPRAY FOR CODLING-MOTH CONTROL

PAONIA, COLORADO, 1922

BY J. H. NEWTON

This experiment was undertaken for the express purpose of testing the value of the dust method of applying lead arsenate for codling-moth control in comparison with liquid spraying under Colorado conditions as found at Paonia, Colorado.

This experiment was made possible through the hearty cooperation of Miss T. L. Hayward, who, being interested in the possibilities of the dusting method, furnished a five-and-three-quarter acre block of

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apples and materials for a practical field experiment. The State Entomological Field Station, located at Paonia, took advantage of this opportunity to carry on a valuable experiment by cooperating to the extent of taking full charge of timing the sprays and personally doing the work of application.

LOCATION OF ORCHARD

This orchard is on Pitkin Mesa in the North Fork Valley of Delta County, 1 1-4 miles northwest of the town of Paonia. Pitkin Mesa is known as one of the best apple-producing sections of Colorado, having a southeast slope and good drainage. Codling-moth control is comparatively easy here when compared with other sections of Colorado, but if allowed to go unchecked the pest would destroy all profits and cause severe loss. For example, in 1919, 98 percent of the fruit was killed by a late spring freeze resulting in a decrease of codling-moth for the season, as there was practically no fruit in which they could mature. The following year, (1920) 98 per cent worm-free fruit was produced with only two sprays, while in 1921 with four and five sprays the worminess averaged 7 percent and where the two-spray method was again tried, the worminess was 25 to 35 percent. Therefore, it may be stated that with favorable seasons for their development, the codling-moth is a serious menace in this valley.

DESCRIPTION OF ORCHARD

The size of the orchard is approximately five and three-quarters acres, planted to nine different varieties of apples as listed in the key to the orchard chart. The orchard has a southeastern slope, good air and water drainage, and is surrounded by apple and peach orchards. The trees are 18 to 20 years old, well pruned, in good health, but too closely planted. A good crop of apples was matured in 1921, followed by a very heavy set in 1922, which necessitated heavy thinning. The average harvest yield for 1922 was ten boxes per tree.

PLAN OF EXPERIMENTAL WORK

The orchard was divided into three blocks (see chart), viz. A, B and C, such that block B, the sprayed portion, constituted approximately the south half of the orchard, while the north half was dusted as blocks A and C. This division of the orchard was the most feasible, as it gave the least possible chance for the dust to drift on to the sprayed block.

Block A.—Dusted with 78 percent arsenate of lead
20 percent hydrated lime
2 percent nicotine sulphate

Block B.—Sprayed with arsenate of lead 2 lbs. to 100 gallons of water

Block C.—Dusted with 15 percent arsenate of lead
83 percent hydrated lime
2 percent nicotine sulphate

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VARIETY CHART OF EXPERIMENTAL ORCHARD

DUST VERSUS SPRAY—PAONIA, COLORADO

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
												J	O	J	J	O	R	W	W	R	O
	O	O	O	O	O	O	R	MP	J	O	R	GS	GS	R	R	R	(8)	R	R	J	O
	O	O	B	J	R	J	J	MP	MP	R	J	J	J	J	J	R	R	R	R	R	O
	J	B	J	O	B	MP	(7)	W	W	B	W	B	B	B	(2)	B	B	B	B	B	B
BLOCK A	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	(B)	(W)	J	B
	B	B	B	B	B	B	B	(1)	B	B	B	B	B	B	(1)	B	B	B	B	B	B
	R	R	R	B	(2)	B	B	B	B	B	B	B	R	R	R	R	R	R	R	R	R
	J	J	(4)	J	(3)	J	J	R	(5)	R	R	R	R	R	R	R	R	(6)	R	R	R
	R	R	R	W	R	(6)	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
	R	J	GR	GR	GR	GR	GR	GR	GR	GR	GR	J	R	J	O	J	O	J	R	R	R
	W	W	W	J	W	(8)	W	W	W	W	W	W	(7)	J	B	(3)	R	R	J	O	O
	W	W	W	W	W	W	W	W	J	R	R	J	R	J	R	R	J	R	R	R	R
	G	G	G	G	G	G	G	G	G	G	G	G	G	R	R	R	R	J	J	R	R
	J	J	J	J	J	J	O	WA	J	R	O	J	WA	WA	WA	WA	WA	WA	WA	J	WA
	R	R	R	R	R	R	R	R	R	R	WA	WA	J	WA	WA	WA	O	WA	J	R	WA
	J	J	J	J	J	R	WA	J	WA	J	J	WA	R	J	J	J	J	J	R	R	O
BLOCK C	R	R	R	(5)	R	R	R	R	R	R	R	J	R	R	R	R	R	J	R	J	O
	R	R	R	J	R	R	R	(6)	R	R	R	R	R	R	(R)	(J)	J	J	R	R	R
	J	J	J	J	J	R	R	R	R	R	R	R	R	(5)	R	J	R	R	R	R	J
	J	J	J	J	O	J	(3)	J	J	J	J	J	J	J	J	J	J	J	J	J	J
	MP	MP	MP	J	MP	J	J	R	MP	MP	MP	MP	MP	MP	MP	J	MP	MP	J	MP	MP
	MP	MP	MP	MP	MP	MP	MP	MP	MP	MP	MP	MP	MP	MP	MP	J	J	MP	MP	MP	MP
	R	R	R	R	R	R	R	R	J	(7)	W	W	W	W	W	W	W	W	W	W	W
	J	J	J	(4)	J	J	J	J	J	J	J	J	J	J	O	J	(4)	J	J	J	J
	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J

BLOCK B

E
N + S
W

VARIETIES: J, Jonathan. W, Winesap. MP, Missouri Pippen. GR, Golden Russet. GS, Golden Sweets. R, Rome Beauty. G, Grimes Golden. O, Vacant places. B, Ben Davis. WA, Walbridge.

Count trees scored thru out the season: (1) and (2), Ben Davis. (3) and (4), Jonathan. (5) and (6) Rome Beauty. (7) and (8), Winesap. Check trees unsprayed: (B), Ben Davis. (J), Jonathans. (R), Rome Beauty. (W), Winesap.

Block A: Dusted with a mixture of 78% inert carrier, 20% arsenate of lead plus 2% nicotine. Block B: Sprayed with arsenate of lead two pounds to 100 gallons. Block C: Dusted with a mixture of 83% inert carrier, 15% arsenate of lead plus 2% nicotine.

( ) COUNT TREES in each block numbered separate in its own series A B,, or C. Like numbers applying to like varieties in each block. So far as possible there were two trees of each variety in each block. There were no Ben Davis in Block C. Check trees (unsprayed) were all located in block B.

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MATERIALS USED

The dusting material was prepared by and purchased from the Niagara Sprayer Company of Middleport, N. Y. Latimer's arsenate of lead was used in the liquid spray.

APPARATUS

The dust was applied with a Niagara Orchard Duster loaned to Miss T. L. Hayward by the Niagara Sprayer Company. The duster was run by a 3 H. P. Z-type Morse engine and was mounted on a low four-wheel truck.

Fig. 10. Orchard duster in operation.

The liquid spray was applied with a Giant Bean Triplex sprayer having two lines of hose, one equipped with a Friend Gun which was used from the ground, and the other with a Bean Majestic angle nozzle of the whirlpool type on an eight-foot rod which was used from the top of the spray tank. A three-thirty-seconds-inch hole was bored through the center of the removable eddy-chamber of the nozzle to insure a solid cone of spray with sufficient driving power for the cone to hold its shape until ten or fifteen feet from the nozzle. What was termed a "medium" disc was used in the gun. A pressure of 275 to 300 lbs. was maintained at all times.

TIMING AND NUMBER OF APPLICATIONS

Five applications, consisting of a calyx and four cover applications were applied to each block.

Timing of sprays was based upon laboratory observations of a large number of moths. These dates were the same as recommended to the community. This being the sixth consecutive year of codling-

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TABLE I

Application	Date applied	Dust			Liquid Spray	
		Quantity	Drift	Approximate time for operation	Quantity	Approximate time for operation
	1922	lbs.	A B	hours	gallons	hours
Calyx spray	May 23-25	200	None Bad	2	2,500	12.5
1st cover spray	June 12-14	200	None Slight	2	2,800	14
2d cover spray	June 23-24	225	No drift. Ideal weather for dusting	2.5	2,800	14
3d cover spray	July 27-29	250	Slight Slight	3	2,800	14
4th cover spray	Aug. 14-16	250	Slight Slight	3	2,700	13.5
	Total	1,125		12.5	13.600	68

Average number pounds dust per tree for entire season ..... 4.91 lbs.
Average number pounds dust per tree per application ..... .98 lbs.
Average number pounds lead arsenate per tree for entire season.
Block A ..... .98 lbs.
Block B ..... .73 lbs.

Average number gallons liquid per tree for entire season 52.3
Average number gallons liquid per tree per application 10.46
Average number pounds lead arsenate per tree for entire season 1.046

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moth life history studies at Paonia, there were sufficient data at hand to judge the most opportune time for spray application.

Previous life-history studies have shown that there are two distinct broods well separated, so that usually two cover sprays to each brood will given ample protection. The seasonal occurrence varies so greatly that calendar dates cannot be set as a criterion.

The dates of application, amounts of material used, and approximate time for application are given in Table 1.

The amounts of liquid spray required for the cover sprays varied little throughout the season because the same operators, machine and nozzles were used. The operators endeavored to completely and thoroughly cover every apple at the least expense, but in so doing found it necessary to use a greater amount of liquid per tree than is the common practice of the grower. Investigation shows that those using less material are not covering all portions of the tree and especially is this true of the top and center.

APPLICATION OF THE DUST

Care was taken to select the quietest periods of the day for dust application to avoid air currents as much as possible. Usually this time occurred during the early part of the afternoon, or between 5 and 7 p. m. Reports from other parts of the country state that their best time is in the early morning for at such a time the dust sticks better because of the heavy dews. At Paonia there is a strong breeze down the valley early in the morning, resulting in practically no dew in the orchards. Only on rare occasions is it possible to apply dust without a slight drift.

The actual time required for applying the dust is very small but even under the most favorable conditions the operators would have to cease operations and wait until the fog of dust cleared away before going back into the tree row. The sudden change of air currents often made it necessary for the operators to face the dust which is not very pleasing when it contains nicotine. This fact made the operating time slower thon that recorded in Table 1. The operators were forced to resort to the use of respirators of the sponge type to relieve irritation of the throat and nose.

The duster was operated at full capacity with a team at a slow walk, and the dust applied to one side of one row at a time. This necessitated driving twice between each row. While only an average of .98 lb. was used per tree per application, the total arsenate of lead on Block A was practically the same as that applied by the liquid spray.

TABLE 2.

COMPARATIVE COST OF MATERIALS AND LABOR PER TREE FOR ENTIRE SEASON.

15-85 Dust mixture (Factory cost plus freight)	$0.515
Cost of labor for application	.062
Total	$0.577

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20-85 Dust Mixture (Factory cost plus freight)	$0.5646
Cost of labor for application	.062
Total	$0.6266
Liquid spray	$0.2405
Cost of labor for application	.38
Total	$0.6205

Table No. 2 shows comparative cost of materials. The dust at either factory price or total cost, including freight, is higher than the the liquid, whereas the liquid is greater by one percent when the labor cost is considered. This estimate does not include the investment in equipment, the cost of its operation, or cost of the nicotine.

METHOD OF CHECKING RESULTS

Varieties considered in the experiment were: Rome Beauty, Grimes Golden, Ben Davis and Winesap.

COUNT TREES—Two count trees of each variety were located in each block except Block B, which had no Ben Davis and only one tree of Winesaps. This made a total of 21 count trees upon which detailed records were made throughout the season. All windfall apples were gathered every two weeks and scored individually for codling-moth injury. The apples thinned off were recorded separately but not con sidered in the harvest windfall results.

CHECK TREES—There was a total of four unsprayed check trees (one of each variety) located in the sprayed block where conditions could be controlled, in order that no poison would reach these trees. Harvest and windfall counts were made as on the count trees. At harvest time every apple in the count and check trees was scored individually the same as the windfall fruit.

An error was made in not having the checks thinned, which resulted in a low percentage of worminess. The worminess for each variety was: Ben Davis, 9.34 percent; Rome Beauty, 15.55 percent; Jonathan, 13.16; Winesap, 8.47; whereas, allowing for the thinning it should have been 15, 23.9, 23.5 and 13.7 respectively. The author does not consider individual check trees situated in a sprayed block as suitable for comparison.

COUNTS ON HARVEST FRUIT

The harvest count is consistent in that Block C ranks above Block A in all respects except the percentage of calyx worms, which is nearly the same in both blocks.

The scoring of the harvest fruit is given in Table 3. Block A consistently shows greater codling-moth injury than Block C even though it received the heavier application of lead arsenate. All available data seem to indicate that Block A had a greater infestation of codling-moth to control. The data in support of this difference of infestation show that there were twice as many injuries per apple in Block A as compared with Block C.

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TABLE 3—DUST VS. SPRAY, HARVEST COUNT, PAONIA, COLORADO, 1922.

	Total Fruit	Free fruit	Worm free fruit	Fruit Injured			Number of Injuries			
				Total	Wormy	Stung only	Calyx	Side Worms	Stings	Total
BEN DAVIS										
Block A										
Dust 20-80	3057	1994	2270	1063	787	276	57	1090	461	1608
Percentage		65.2	74.3	34.8	25.7	8.9	1.9	35.6	15.1	52.6
Block B										
Spray	2502	2355	2458	147	44	103	0	57	111	168
Percentage		94.1	98.2	5.9	1.8	4.1	0	2.3	4.4	6.7
Block C										
Dust 15-85		No Ben Davis in this block								
JONATHAN										
Block A										
Dust 20-80	3180	2222	2413	958	767	191	86	1264	405	1757
Percentage		69.9	75.9	30.1	24.1	6.1	2.8	38.0	12.7	55.2
Block B										
Spray	3443	3323	3415	120	28	92	3	33	105	141
Percentage		96.5	99.2	3.5	0.8	2.7	0.1	1.0	3.1	4.1
Block C										
Dust 15-85	3299	2682	2804	617	495	122	133	595	176	904
Percentage		81.3	85.0	18.7	15.0	3.7	4.0	18.0	5.3	27.4
ROME BEAUTY										
Block A										
Dust 20-80	2006	1215	1389	791	617	174	12	935	379	1326
Percentage		60.6	69.2	39.4	30.8	8.7	0.6	46.6	18.9	66.1
Block B										
Spray	2349	2181	2319	168	30	138	0	39	166	205
Percentage		92.8	98.7	7.2	1.3	5.9	0	1.7	7.1	8.7
Block C										
Dust 15-85	2159	1834	1914	325	245	80	1	360	134	495
Percentage		85.0	88.7	15.0	11.3	3.7	0.0	16.7	6.2	22.9
WINESAP										
Block A										
Dust 20-80	1775	1292	1473	483	302	181	3	460	324	787
Percentage		72.8	83.0	27.2	17.0	10.2	0.2	25.5	18.3	44.0
Block B										
Spray	1971	1839	1960	132	11	121		13	148	161
Percentage		93.3	99.4	6.7	0.6	6.1	0	0.7	7.5	8.2
Block C										
Dust 15-85	960	810	883	150	77	73	2	119	114	235
Percentage		84.4	92.0	15.6	8.0	7.6	0.2	12.4	11.9	24.5

PERCENTAGE AVERAGE FOR ALL VARIETIES

Block A						
Dust 20-80	67.1	75.6	32.9	24.4	8.5	1.3
Block B						
Spray	94.2	98.9	5.8	1.1	4.7	0.1
Block C						
Dust 15-85	83.5	88.5	16.5	11.5	5.0	1.4

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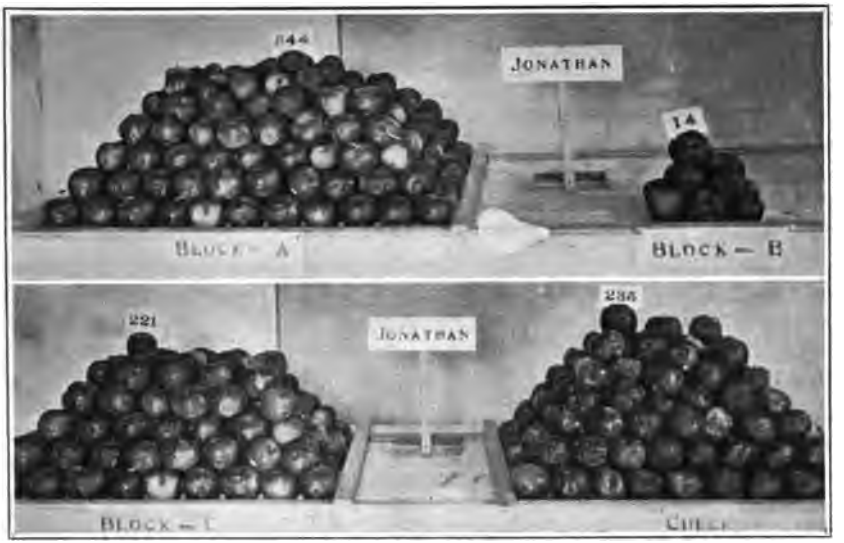

Fig. 11. Results expressed in number of wormy apples per 1000. Harvest plus windfall count. Note the small number of wormy apples in sprayed block (B) as compared with the dusted blocks A and C or the check.

The count trees in the sprayed block (B) also show a greater infestation in the east end of the orchard, but this difference is not so pronounced because of the effective control of the spray work. The check trees reverse the result and this might be expected, due to variation of individual trees while in the case of the count trees a larger number of trees are well separated so as to give a fairer average.

Comparing block C with the sprayed block, the following points are outstanding (average of all varieties) :—

Fig. 12. Comparison of harvest fruit on two trees having an equal crop. Those on the left from Block A, those on the right from Block B. Note also number of wormy apples as compared with the clean fruit (in boxes) in each case.

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	Dust	Spray
No. apples per 100 free from codling moth injury	83	94
No. apples per 100 free from worms	88	99
No. apples per 100 that were wormy	12	1
No. apples per 100 having calyx worms	1.5	0.08

For exact percentages see Table 3.

HARVEST PLUS WINDFALL COUNT

While the harvest count gives the final product of control work as a marketable quantity, it does not express the true result because it is the tendency of wormy apples to fall to the ground and thus escape consideration. The only true basis upon which to judge results is a record of the codling-moth injuries upon both harvest and windfall fruit for the season. Their sum represents the true amount of fruit selected for protection and the total count shows the actual protection resulting from control work.

Taking the harvest plus windfall count, the data gave the following average for all varieties:

	Dust	Spray
No. apples per 100 free from codling moth injury	78	94
No. apples per 100 free from worms	83	98
No. apples per 100 that were wormy	16	1.5
No. apples per 100 having calyx worms	3.29	0.01

For exact percentages see Table 4

RATIO OF STINGS TO TOTAL INJURIES

The ratio of stings to total injuries is interesting. The sum of the stings and worms may be taken as an index of the infestation and the stings as an index of the worms killed, while their ratio may indicate the efficiency. This ratio may vary with the variety according to the skin texture, or a heavy infestation of codling-moth may give a higher degree of efficiency than a lower infestation, resulting in cleaner fruit. However, under the same conditions this ratio will indicate the relative value of different methods. Upon this basis the following table is of interest.

	Percentage of Total Injuries Resulting in Stings				
	Ben Davis	Romes	Jonathans	Winesap	Average
Block A.	21.44	25.13	17.85	35.26	24.92
Block B.	59.79	76.41	62.94	88.26	71.85
Block C.		22.70	13.60	39.17	25.15

The above data indicate that for all varieties the spray killed a larger percentage of the worms that tried to enter the fruit than did the dust in either block A or C.

RESULTS OBTAINED BY THE GROWERS

Table 5 shows that the growers in this section who are following the spray schedule and doing thorough work are obtaining good results. In such cases as Nos. 12 and 13 the spraying was done by poor sprayers.

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TABLE 4—DUST VS. SPRAY, HARVEST AND WINDFALL COUNT, PAONIA, COLORADO, 1922

	Total fruit	Free fruit	Worm free fruit	Fruit Injured			Number of Injuries			
				Total	Wormy	Stung only	Calyx	Side worms	Stings	Total
BEN DAVIS										
Block A										
Dust 20-80 4354	2731	3220	1623	1329	294	124	1953	567	2644	
Percentage ...	71.00	74.2	29.0	25.8	3.2	2.9			60.7	
Block C										
Dust 15-85	No Ben Davis in this block									
Block B										
Spray 2583	2418	2522	165	61	104	0	78	116	194	
Percentage	93.6	97.6	6.4	2.4	4.0	0			7.5	
JONATHAN										
Block A										
Dust 20-80 ...3980	2370	2612	1610	1368	242	159	2095	490	2744	
Percentage ...	59.6	65.6	40.5	34.4	6.0	4.0			69.0	
Block C										
Dust 15-85....3793	2824	2956	969	837	132	215	1011	193	1419	
Percentage	74.5	78.0	25.5	22.0	3.5	5.7			34.0	
Block B										
Spray 3704	3560	3653	144	51	93	3	60	107	170	
Percentage	96.1	98.6	3.9	1.4	2.5	0.1			5.1	
ROME BEAUTY										
Block A										
Dust 20-80....2383	1366	1548	1019	837	182	20	1258	429	1707	
Percentage	57.3	65.00	42.7	35.00	7.6	0.8			71.5	
Block C										
Dust 15-85 2336	1899	1988	437	348	89	3	511	151	665	
Percentage	81.3	85.1	18.7	14.9	3.8	0.1			28.5	
Block B										
Spray 3149	2963	3107	186	42	144	0	54	175	229	
Percentage ...	94.0	98.7	6.00	1.4	4.6	0			7.3	
WINESAP										
Block A										
Dust 20-80 1954	1317	1499	637	445	182	8	675	372	1055	
Percentage	67.4	76.7	32.6	23.3	9.3	0.4			54.00	
Block C										
Dust 15-85....1009	816	889	193	120	73	7	170	114	291	
Percentage	80.9	88.1	19.1	11.9	7.2	0.7			28.8	
Block B										
Spray 2024	1886	2008	138	16	122	0	20	149	169	
Percentage	93.2	99.2	6.8	0.8	6.0	0			8.4	
PERCENTAGE AVERAGE FOR ALL VARIETIES										
Block A										
Dust 20-80	63.8	70.3	36.2	29.7	6.5	2.1				
Block C										
Dust 15-85	78.9	83.7	21.1	16.3	4.8	2.2				
Block B										
Spray	94.2	98.5	5.8	1.5	3.3	0.1				

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TABLE 5—HARVEST COUNTS IN ORCHARDS IN THE NORTH FORK VALLEY, DELTA COUNTY, COLORADO, 1922.

Orchard No.	Total fruit	Free fruit	Worm free fruit	Fruit Injured			Number of Injuries				Spray Schedule Variety
				Total	Wormy	Stung only	Side Worms	Calyx Worms	Total Worms	Total Stings	
1	500	438	493	62	7	55	7	1	8	82	5 sprays
Percent ...		87.6	98.6	12.4	1.4	11.0	1.4	0.2	1.6	16.4	Grimes
2	500	436	489	64	11	53	11	1	12	79	5 sprays
Percent ...		87.2	97.8	12.8	2.2	10.6	2.2	0.2	2.4	15.8	Grimes
3	962	928	950	34	12	22	14	0	14	23	5 sprays
Percent ...		96.4	98.7	3.6	1.3	2.3	1.5	0	1.5	2.4	Jonathan
4	1000	798	895	202	105	97	172	0	172	149	5 sprays
Percent ...		79.8	89.5	20.2	10.5	9.7	17.2	0	17.2	14.7	Jonathan
5	1000	745	919	255	81	174	93	10	103	268	5 sprays
Percent ...		74.5	91.9	25.5	8.1	17.4	9.3	10.0	10.3	26.8	Winesap
6	300	255	291	45	9	36	10	0	10	40	5 sprays
Percent ...		85.0	97.0	15.0	3.0	12.0	3.3	0	3.3	13.3	Gano
7a	500	351	485	149	15	134	24	0	24	198	5 sprays
Percent ...		70.2	97.	29.8	3.0	26.8	4.8	0	4.8	39.6	Romes
7b	500	288	445	212	55	157	98	1	99	293	4 sprays
Percent ...		57.6	89.0	42.4	11.0	31.4	19.6	0.2	13.8	58.6	Romes
8	1580	1467	1555	113	25	88	26	1	27	104	5 sprays
Percent ...		92.8	98.4	7.2	1.6	5.6	1.6	0.1	1.7	6.6	Grimes
9	2240	2013	2060	227	180	47	196	13	209	55	5 sprays
Percent ...		89.9	92.0	10.1	8.0	2.1	8.7	0.5	9.2	2.4	Jonathan
10	400	309	354	91	46	45	56	5	61	83	5 sprays
Percent ...		77.3	88.5	22.7	11.5	11.7	14.0	1.3	15.3	20.8	Delicious
11	155	89	142	66	13	53	17	0	17	87	5 sprays
Percent ...		57.4	91.6	42.6	8.4	34.2	10.9	0	11.0	56.1	Winesap
12	200	139	185	61	15	46	24	0	24	78	5 sprays
Percent ...		69.5	92.5	30.5	7.5	23.0	12.0	0	12.0	39.0	W.Pearmain
13	1337	1075	1226	262	111	151	119	25	144	232	5 sprays
Percent ...		80.4	91.7	19.6	8.3	11.3	8.9	1.9	10.8	17.4	Jonathan
14	883	761	830	122	53	69	62	13	75	90	5 sprays
Percent ...		86.2	94.0	13.8	6.0	7.8	7.0	1.5	8.5	10.2	Grimes
15	800	774	789	26	11	15	12	1	13	18	5 sprays
Percent ...		96.8	98.6	3.2	1.4	1.9	1.5	0.1	1.6	2.3	Jonathan
16	500	465	484	35	16	19	16	2	18	23	5 sprays
Percent ...		93.0	96.8	7.0	3.2	3.8	3.2	0.4	3.6	4.6	Jonathan
17	300	252	282	48	18	30	20	1	21	36	(?)
Percent ...		84.0	94.0	16.0	6.0	10.0	6.7	0.3	7.0	12.0	Winesap
18	608	450	558	158	50	108	67	3	70	196	5 sprays
Percent ...		74.0	91.8	26.0	8.2	17.8	11.0	0.5	11.5	32.2	Romes
19	405	362	392	43	13	30	17	0	17	33	5 sprays
Percent ...		89.4	96.8	10.6	3.2	7.4	4.2	0	4.2	8.2	Grimes
20	270	204	237	66	38	33	43	5	48	52	5 sprays
Percent ...		75.6	87.8	24.4	12.2	12.2	15.9	1.9	17.8	19.3	Jonathan
Total	14940	12599	14061	2341	879	1462	1104	82	1186	2219	
Percent ...		84.3	94.2	15.7	5.8	9.8	7.4	0.5	7.9	14.9	

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Numbers 7-a and 7-b show an increase of 8 percent worminess when the second cover spray was omitted.

The average of 5.8 percent wormy harvest fruit for twenty growers is very good. Some of the growers produced practically as clean a crop as recorded in the spray work of the 1922 experimental orchard, but such results came only from the most thorough orchardists and in most cases the size of the orchard permitted personal supervision by the owner.

SUMMARY

This report should not be taken as conclusive evidence of the relative value of dust and liquid spray. This view is taken because the data cover only one season's experience. However, the data at hand do not indicate any protection from the dust comparable with that from the liquid spray.

ANJOU PEAR TROUBLE IN MESA COUNTY

By W. P. YETTER, JR.

About the time the Anjou pears were ready to be picked, it was discovered that something serious was troubling the pears and this trouble was just beginning to be evident to casual observations. As these pears are high priced the growers naturally became concerned. Field observations showed that nearly every Anjou pear orchard was troubled with what most of the growers were terming the "Anjou fungous."

As a result of this trouble, the growers suffered a very great loss because they were obliged to sell at a greatly reduced price as nobody wanted to buy these pears and run the risk of losing them either in cold storage or in transportation.

Specimens of these pears were sent to Dr. M. B. Waite, Pathologist in charge, Fruit Disease Investigations, Bureau Plant Industry, U. S. D. A., Washington, D. C., and to Dr. A. L. Quaintance, Entomologist in charge, Fruit Insect Investigations, Bureau of Entomology, U. S. D. A., Washington, D. C., and they have the following to say:

Dr. Waite reports as follows:

"This pear disease which we call stigmonose is the after effects of insect punctures. This is an old trouble with the pears which we have known for years but it was a puzzle for a long time, principally because it was in evidence only towards picking time. This is undoubtedly plant-bug stigmonose produced by the punctures of plant bugs. We found out the cause of it here in the east more than ten years ago and I have an excellent colored print in my collection of an Anjou pear mailed to me by F. R. Daivs of Grand Junction, Colorado, dated Sept. 14, 1911. I found this stigmonose on the Bosc pear out of storage from Medford, Oregon, sent in April, 1910; have known it in California on the Bartlett where it seriously bothered the canners. On the Bartlett it makes a harder, woodier spot than on the Anjou and this hard spot catches on the knives in paring. I have had complaints of it, with the description of the disease, from South Africa where some similar puncturing-insect produced the same effect. I find it,

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in fact, on my old photographs, made thirty years ago, of New York pears. A similar thing occurs on apples, peaches and plums.

The only difference between the types that I have seen before and the Anjous that you sent in (these were sent in by Mr. Locklin) is that a number of the fruits showed clusters of this damage rather than single punctures. I think this is just a case of the bugs being more numerous than usual. Where these clusters occur the corky area extended deeper than the single puncture. I may say that in our experience the spots of this stigmonose have not proved very serious in the storing and keeping qualities of the fruit, though of course, such spots detract from the market value and grade, especially of the fine fruit like the Anjou. The unusual outbreak which you have had this season is probably due to increased numbers of plant bugs for some cause. I may say that I ran across this trouble when I was in Grand Junction, Colorado, in 1910."

Dr. A. L. Quaintance has the following to say:

"I note that Dr. Waite had written you rather fully and diagnosed the trouble as stigmonose. This of course is a general name for the after-effects of insect punctures, principally plant bugs and plant lice. Plant bug injury to apples, pears and peaches is frequently complained of and in some parts of the country the trouble has become rather chronic due to the presence of certain species, the control of which is rather regularly taken into account. I have in mind particularly the so-called apple red bugs, *Heterocordylus malinus* and *Lygidea mendax*. These insects puncture, especially the apple, causing more or less of dimpling and stigmonose effect and have been the subject of considerable study by the Geneva, N. Y., Experiment Station, and doubtless you have publications on these insects. The so-called tarnished plant bug, *Lygus pratensis*, is also guilty of dimpling and perhaps also some of its near relatives. The effect of the plant-bug puncture evidently varies much with age of fruit when attacked. The ordinary stigmonose effect probably results from late attack, whereas the dimpling is due to attack early in the season."

Mr. H. D. Locklin, Chief Deputy State Horticulturist of Colorado, spent the season in Mesa County and when the Anjou pear trouble was brought to his attention he at once began to make investigations. He also had a number of boxes of Anjou pears put in cold storage which he later examined and the report of his findings is as follows:

DESCRIPTION OF SPOT ON NORMAL FRUITS

"Inside Appearance of Spot.—Brown spot consists of numerous cavities varying in size from a fraction of a mm. to 5 or 6 mm. in length. Most cavities are about one-half as wide as long. The brown coloring of the spot is caused by the light-brown lining or sides of these cavities. There are normal cells between these cavities. There is no distinct line between the brown spots and the normal white flesh. Often there is one cavity at the center of the spot which is much larger than the other cavities of that spot. The largest cavities are in the center of the spot. Toward the edges the cavities gradually become smaller and less numerous till they finally disappear. The smaller the spot the less likely they are to show at the surface. The spots apparently start 8 to 10 mm. below the surface and spread in all directions. The taste of the brown spots is slightly bitter. The browning of some small spots never get nearer than 5 to 7 mm. to the

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skin. The flesh between these small spots and the skin is apparently normal in every way.

"Outside Appearance of Spots.—The surface is depressed below the general surface of the fruit. In large spots the center of this depressed area may be slightly raised. In a few cases this depressed area had a more granular appearance than the rest of the skin. With a few exceptions, the outside color of the spot (on skin) is dark green, even when normal, the skin is a good yellow. On a few of the smallest spots there was only the very slightest depression. In fact in these few cases the spot was more flattened than depressed. The skin of these exceptions was a normal color and was wrinkled as when the fruit shrivels up. These few spots were not hard at the surface as the normal spots.

DESCRIPTION OF SPOT ON DECAYED FRUIT

"Inside Appearance of Spot.—When flesh is broken down and clear in color the spots are granular and grayish instead of brown as before. This may be due to the good cells between cavities becoming clear from breaking down and the brown lining of the cavities becoming darkened. When fruit is soft from breaking down, the spots are tough and can be picked out as a whole leaving a cavity in the flesh of the pear. The good flesh becomes soft before the spots, but the latter finally becomes soft also.

"Outside Appearance of Spot.—The only change in appearance of the spots when the fruit decays is that the color changes from a dark green to a clear watery color at the edges of the spot with a whitish granular appearance over the center of the spot.

"Most all break down from organisms coming in at the skin break. Very little, if any was caused by the spots. Most of the fruits with several spots being in perfect condition when the fruit was well ripened. Some of the decay was from the natural breaking down of the flesh from becoming over ripe. When the fruit started to break down from natural causes rather than from an organism, the breakdown usually started in the region of a group of spots.

INDICATIONS OF INSECT INJURY

"There was no indication of insect injury in any of the 166 spots examined. One spot had a whitish thread running from the skin to the spot, but similar threads were seen at other positions throughout the flesh. The other spots had a group of stone cells at the surface or skin, resembling very much the group of similar cells in the decayed spots. None of these abnormalities appeared to be insect injury."

LIME-SULPHUR TESTS

By W. P. YETTER, JR.

For some time past there have been discussions and arguments in various quarters, especially among the manufacturers of dry lime-sulphur, to the effect that equal amounts of dry and liquid lime-sulphur taken on the basis of sulphur and other substances present were not equal in killing power and that the dry will give better results than the liquid on account of the presence of materials other than the sulphur.

Analyses made by several experiment stations show that the material present in the dry (which is supposed to make the dry more effective) is sugar.

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These arguments of the manufacturers of lime-sulphur sprays led us to undertake an experiment to test the dry products and to see if, where sugar was added to smaller amounts of liquid lime-sulphur, it would be as effective as the regular amount used with no sugar present.

The H. Hickman orchard, 4 miles east of Grand Junction, which was badly infested with San Jose scale, was secured for the experimental work. This orchard was divided into seven plots, to five of which the liquid lime-sulphur was applied, and to two, the dry lime-sulphur. An eighth plot was secured in the orchard of T. Arbuckle west of Grand Junction and the dry lime-sulphur was applied here also.

A check plot was not reserved nor was an accurate count made before spraying to determine the natural mortality of the San Jose scale. However, just before spraying, a very general examination was made which showed a good percent of the scale to be alive and that the mortality during the winter months had been rather low.

While the results of the spraying are good commercially, we do not care to go on record as making any recommendation from these data. It would be necessary to complete several year's work under various conditions before this would be safe.

The materials used in this work were donated by the Sherwin-Williams Company and the Latimer-Goodwin Chemical Company.

The table below shows the percent of killed scales, the percent of apples infested with scale at harvest time, the number of scales on the new wood and the amounts of spray materials used.

Plot No.	Amount of Materials Used	Percent Killed	Percent Apples Infested at Harvest Time	New Wood Examined	
				June 29	Oct. 20
1	17½ gal. liquid to 200 gal. water+2 lbs. lime-caseinate	98.07	0.53	No scale	No scale
2	17½ gal. liquid to 200 gal. water	98.08	0.15	No scale	No scale
3	8½ gal. liquid to 200 gal. water+5 lbs. sugar+2 lbs. lime-caseinate	98.54	2.12	No scale	No scale
4	14 gal. liquid to 200 gal. water + 5 lbs. sugar	98.91	No fruit to count	No scale	No scale
5	8½ gal. liquid to 200 gal. water	95.42	No fruit to count	No scale	No scale
6	49 lbs. dry to 200 gal. water	95.50	No fruit to count	No scale	No scale
7	56 lbs. dry to 200 gal. water	100.00	No fruit to count	No scale	No scale
8	50 lbs dry to 200 gal. water	98.58	2.55	No scale	2 scales

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The above table shows some interesting results. For instance, plots No. 1 and 2 were sprayed with the same materials with the exception of the addition of lime-caseinate to plot No. 1. There was no difference in the results, which would indicate that the lime-caseinate did not increase the killing quality of the lime-sulphur.

Plots No. 3 and 5 are very interesting because of the low dilutions used and the percent of kill obtained. In plot No. 3, 8½ gal. of the liquid lime-sulphur to 200 gal. of water plus 2 lbs. of lime-caseinate and 5 lbs. of granulated sugar gave 1.02 percent better kill than in plot No. 5 with no other materials added. These low dilutions gave almost as good a kill as in plots 1 and 2 where twice the amount of lime-sulphur was used.

In plot No. 4, 14 gal. of the liquid lime sulphur to 200 gal. of water plus 5 lbs. of granulated sugar, gave the best results secured in any of the liquid plots.

The data on plots 3 and 4 indicate that the low dilutions of liquid lime-sulphur have a high killing power, but the addition of sugar and lime-caseinate in plot No. 3 did not increase this materially.

In the dry lime-sulphur plots, plot No. 8 shows a 3.08 percent better kill than plot No. 6. This difference might possibly be attributed to the nozzle holder as different men did the work. Plot No. 7 shows perfect control but the infestation was so light that a satisfactory count could not be made.

PEACH TREE FUMIGATION

BY GEO. M. LIST AND W. P. YETTER, JR.

For a number of years the peach growers in the Palisade section have been having a very heavy loss in their newly planted peach trees, especially where these trees have been planted on land that has been under cultivation for a number of years. The trees start growth in a normal way in the spring but die during the growing season even after several inches of new growth has been made. Little or no new root growth is made and the old roots are blackened. This loss has been attributed to a number of causes but the one most commonly advanced by the growers has been the fumigation with hydrocyanic acid gas which has been required on all stock coming into the state. In order to determine whether or not this might be responsible it was arranged to secure a number of trees that had not been previously fumigated and make a number of tests and then plant the trees under different conditions to determine if different soil conditions that are known to exist in that section might not be at least partly responsible. For this work 100 yearlings 3-to-4-foot Elberta trees were donated by the Huntsville Nurseries of Huntsville, Alabama. These trees arrived in Fort Collins by express on March 4 in good condition. They were stored in the original package in a natural-temperature vegetable store-room until April 14, when they were buried in moist soil. At the

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time they were buried a few of the small twigs at the tip of the bundle had shriveled slightly. Otherwise, they appeared to be in excellent condition. The roots had been kept moist. They were removed from the soil April 22 and the fumigations made by Mr. J. L. Hoerner. The trees at this time were in good condition. A few of the buds had begun to swell. Occasionally a flower bud showed a small amount of pink. The following table gives the information in regard to the different fumigation tests made:

PEACH TREE FUMIGATION

Test No.	Number trees used	Dosage of cyanide per 100 cu. ft.	Time of exposure	Condition of trees	Temperature
1	20	Potassium cyanide, 1 oz.	45 min.	Dry	65 deg. F.
2	20	Potassium cyanide, 1 oz.	45 min.	Wet	65 deg. F.
3	20	Sodium cyanide, 1 oz.	45 min.	Dry	62 deg. F.
4	20	Check			
5	5	Potassium cyanide, 2 oz.	45 min.	Dry	68 deg. F.
6	5	Potassium cyanide, 1 oz.	90 min.	Dry	55 deg. F.
7	5	Potassium cyanide, 1 oz.	60 min.	Dry	60 deg. F.
8	5	Sodium cyanide, 2 oz.	45 min.	Dry	62 deg. F.

The fumigation required for nursery stock coming into the State consists of the use of one ounce of potassium or sodium cyanide to each 100 cubic feet of space with an exposure of 45 minutes. The fumigation must be done in a tight enclosure.

The trees were so divided that this fumigation could be given to part of them, using both the potassium and sodium cyanide. In most of the tests the trees were dry. In Test No. 2 they were sprinkled with water just before fumigation. In other tests either the amount of cyanide or the length of exposure was increased to determine if any injury would occur.

After fumigation, the trees were cut back to a height of about 18 or 20 inches as they are before being planted in the orchard. Ten trees of tests numbers 1, 2, 3, 4, and all of the trees of tests numbers 5, 6, 7, and 8 were planted in a nursery row in the College garden in Fort Collins. Seven trees of tests Nos. 1, 2, 3 and 4 were planted on land that had previously been in a peach orchard on the place of J. H. Cutter, Palisade, Colorado. Three trees of tests Nos. 1, 2, 3 and 4 were planted on the L. E. Jaynes place, Grand Junction, Colo. The soil in the College garden at Fort Collins would be a fair representation of the

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soil in this section of the State. That in the J. H. Cutter place at Palisade had been in orchard and would be a fair sample of the type of soil that is being reset to orchards in the Palisade section. The soil in the L. E. Jaynes place has had probably better care in the way of crop rotation and the addition of humus than is general in the Mesa County fruit-growing section.

All of the trees planted at Fort Collins made a growth of from 3 to 6 feet. We were unable at any time during the season to distinguish those that had received different treatment from the checks. Those planted at Palisade started growth in the spring, apparently in a normal way, but as the season progressed, they began dying. It was found that practically no new roots were being developed. Before the season was over all the trees, including the checks, had died. Those planted at Grand Junction started growing in a normal way but due to lack of water at just the proper times did not make a very large growth. The three check trees died but those that had been fumigated lived through the season and made a growth of from 10 to 20 inches.

This would seem to indicate that the fumigation has not been responsible for the loss of trees but that it is probably due to a soil condition. This condition is of such a nature that it might possibly vary within the same field and would undoubtedly vary in the different localities in the peach-growing section. The trees that were grown in Fort Collins will be carried over winter and planted at Palisade on the J. H. Cutter place next year.

NOTES ON RODENT PESTS

By W. L. BURNETT

One of the outstanding features of rodent activities in the State this year was the extensive campaign carried on for prairie-dog control, through organized pest districts in the following counties: Weld, Adams, Arapahoe and Fremont; also, the cleanup work done in Douglas County. Several other counties in the State put on very effective campaigns on a smaller scale.

Early in the season at a meeting of the cooperating parties for rodent control, namely, the State Entomologist, State Extension Service, and the U. S. Biological Survey, an agreement was reached whereby the work in certain counties was to be looked after by the State Entomologist's office, and certain counties by the Biological Survey.

Heretofore, a certain amount of duplication of work had been going on, and by this arrangement we hoped to eliminate this to a large extent. This arrangement worked out fairly satisfactorily, and we would suggest that the same plan be carried out for the season of 1923.

When the outline of this agreement was worked out, it was not the intention of this office to authorize anyone not a legal representa-

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tive of the State Entomologist's office to have charge of the work in the various counties working under organized pest districts. The State Entomologist and his deputies, or county pest inspectors, are the only ones authorized by law to carry out the provisions of the Pest Act.

We have endeavored, as far as funds and time would permit, to keep in touch with the work in pest districts in the various counties. However, more time has been given to those counties designated in the before-mentioned agreement, as the ones to be looked after by this office.

On account of lack of funds and time, we are compelled to neglect one of the most important phases of rodent control, "life history." To the average individual, this may seem of minor importance, yet without full knowledge of the subject, the efficiency of our work is reduced.

One of the essential points in life history studies, is the food habits of our rodents. A lack of this knowledge is fully illustrated in the problem of controlling the Zuni prairie dog in the southwestern section of the state. Further remarks in detail relative to this problem will be found in this report under Montezuma County.

The study of the life history of injurious rodents in Colorado is practically a virgin field. What little work has been done only serves to illustrate how little we know of the subject.

If sufficient funds were available, a special study should be made of the life history of all the rodents found in the State, especially of the prairie dogs, ground squirrels and pocket gophers. With more detailed information along these lines, we would be in a better position to cope with the different problems in rodent control as they come to us. New problems are coming up each year, and each year they are becoming more complex. These problems are largely local ones and the work done along similar lines in other states is of little practical value in solving them.

POCKET GOPHERS

Three genera of pocket gophers are represented in Colorado, *Thomomys, Geomys* and *Cratogomys,* with ten species or varieties, eight of which belong to the genus *Thomomys,* and one each to *Geomys* and *Cratogomys.*

The genus *Geomys* is confined to the plains regions of eastern Colorado and the genus *Cratogomys* to a rather restricted region in the southeastern portion of the State. The genus *Thomomys* is, with few exceptions, confined to the more mountainous regions, occurring in some localities at an elevation of over 11,000 feet.

Pocket gophers are becoming a greater pest each year, and at the present time are a serious menace to orchards, ditch banks, alfalfa fields and mountain meadows, and to some extent cultivated fields.

For the control of pocket gophers we are strongly in favor of traps, in preference to poison (unless the area to be treated is too extensive). We believe that a systematic use of the Macabee gopher

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trap will prove more satisfactory than any other method for control.

We realize that the time involved in trapping is greater than with the use of poison. If the prod method of placing poison is used, one can cover the ground quite rapidly, but we question if results obtained from this method are as effective as traps, even with the extra time taken into consideration.

For our plains gopher, *Geomys lutescens,* it is not practicable to use a prod for locating the main runways, where poison to be effective must be placed. In the alfalfa fields and meadows the runways of *lutescens* vary in depth, but fully 75 percent of them are too deep to use a prod successfully. We have found a considerable number of these runways over two feet beneath the surface.

We have this season carried on some quite extensive experimental work with traps for gopher control. We find that by using the proper methods of setting that our catch averaged about 80 percent. We believe that possibly, with the exception of *clusius,* the genus *Thomomys* is easier to trap than the genus *Geomys.* However, the most of our trapping for *clusius* was done in the hard soil of the plains region, not in the loose soil of the mountain meadows. Soil conditions, we believe, are important factors relative to the success of gopher trapping.

We attribute our lower percentage of catch with *Geomys,* besides soil conditions, largely to the size of trap used, as we were using the smaller trap, not the size recommended for the plains gopher.

During the year a number of demonstrations for gopher control with traps were made, instructing the farmers as to the right trap to use and proper methods of setting same. Mr. Corkins and County Agent Sawhill of Pueblo County held two of these demonstrations among the Italian gardeners on St. Charles Mesa near Pueblo. From results of these demonstrations over 400 Macabee gopher traps were used on the mesa during the summer, and the gopher practically exterminated on an area of about 600 acres.

PEST DISTRICTS

Forty-one new pest districts were organized during 1922. These embrace approximately 950,000 acres. They are located as follows by counties: Delta, 1; Fremont, 1; Pueblo, 2; Otero, 7; Lincoln, 2; Weld, 8; Arapahoe, 5; Adams, 9; San Miguel, 5; Montrose, 1.

In the greater number of these districts, very effective work has been done. The partial failure in the other districts is due to a lack of cooperation, proper supervision or a lack of funds.

We would suggest that pest districts be organized only in counties where the county commissioners are in a position to furnish the necessary revolving funds to carry the work to completion and provide a county pest inspector that can give the necessary time to the work. A poorly organized campaign always results in unsatisfactory results with added expense to both the land owners and the county.

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"Final clean up" should be the slogan of all land owners, county pest inspectors and county commissioners entering into a campaign. It is a simple matter to destroy the first 95 percent of the prairie dogs, but the real test comes in freeing the land of the remaining 5 percent. Unless this is accomplished the work can give only temporary relief.

POISONED-GRAIN SITUATION

We find that poisoned grain prepared at our laboratory at the Colorado Agricultural College, and that mixed by the different counties having experienced help give much better results than that which is prepared by individuals and firms throughout the State. As a rule, these parties are putting out this grain as prepared according to our formula, but with certain changes that they think will improve it. The consequence has been that this office is being blamed for the inferior grades of prairie-dog poison which are upon the market in certain sections of the State. One firm had added a considerable amount of white arsenic. This is a drug firm that should know better. Others are putting it out lumpy, and with insufficient directions for use. If directions are followed carefully, there is no excuse for lumpy grain.

We sometimes question the advisability of placing a copy of these formulae in the hands of individuals. On the other hand, they have been developed with the taxpayers' money, and we feel that they are entitled to them.

WASHINGTON COUNTY

Early this spring arrangements were made with the commissioners of Washington county to organize a limited number of pest districts in the southwest corner of the county, for prairie dog control. Mr. Robert W. Vance was appointed pest inspector, and the commissioners agreed to allow him one or more deputies, as was thought advisable after the work was started. A revolving fund of $1,000.00 was set aside to purchase poison supplies, and take care of the work on non-resident land in the district. Mr. Vance reports in part as follows:

"Work was taken up in three townships and was completed excepting for some follow-up work in order to get what dogs we missed the first time over.

"My plan of procedure, as I realize now, was not practical and for that reason the work was not as satisfactory as was expected. My plan, as was carried out, was to divide each township into four equal parts, placing some resident landowner in charge and hold him responsible for the killing of the dogs in his particular district. Some of the leaders did not function and the work had to be handled by some successful cooperator on the outside."

FREMONT COUNTY

Four pest districts for prairie-dog control were organized in Fremont County last year, and one this spring. At the time the four districts were organized, no provisions were made by the county commissioners to take care of the work. This spring the commissioners appointed Mr. W. H. Pigg, county pest inspector. Mr. Pigg is field

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man for the U. S. Biological Survey, working in cooperation with the Stockgrowers' Association in northern Fremont and southern Park Counties. The following is from County Agent Taylor's report:

"Excellent results have been secured in all districts. We have had complaints to the effect that only six landowners in the five districts have not poisoned for dogs according to the regulations of the districts. Our prairie-dog eradication work this year may be summarized as follows: 125 farmers put out poison, the total acreage of infested land treated was 30,000. The estimated number of dogs killed was 44,000."

MESA AND MONTROSE COUNTIES

Mr. C. L. Corkins, from this office, inspected the districts in these counties, and the following excerpts are made from his report:

MESA COUNTY.—"The Whitewater district in Mesa County is surrounded on three sides by heavily infested prairie-dog territory. Only in the east side of the district, where the Grand Mesa is used as a boundary line, is there any natural protection from prairie-dog migration.

"In order to prevent future reinfestation in this district, an area bounded on the north by Vinelands, on the west by the Gunnison River, on the south by Deer Creek, and on the east by Grand Mesa, should be included in pest districts. This would require approximately three more townships to be organized in the district. Very little of the remaining territory is agricultural land.

"The Redland district is protected on two sides from reinfestation. On the south it extends to the mountains, and on the north it is bounded by the Gunnison River. However, the territory to the east and west is not especially dangerous."

MONTROSE COUNTY.—"The Redvale District in Montrose County, with the exception of the failure to include about 1,000 acres in the northwest corner, is very favorably bounded with natural barriers.

"On the north occurs the San Miguel River, on the west, Naturita Creek, on the south the county line, and on the east, with the exception of the territory just mentioned, Maverick Draw."

County Agent King, of Montrose County, reports on prairie-dog work in the county in part as follows:

"The control of the prairie dog is one of the main activities of this office. The topography of the county is such that it means a continuous fight to keep this pest within bounds. With the cultivated lands in the valley surrounded by waste land on all sides extending back for miles into the hills, it means a breeding ground for the dogs that it is hard to get control measures on. Most of the organized pest districts in the county have expired, there being only two in the county at the present time, with one being reorganized. These pest districts have kept down the infested spots within the cultivated districts, which is some assistance to the neighboring farms, but they have little effect on the migration from the hill range land.

"The total amount of poisoned grain prepared in the county this year was 8,080 pounds. This grain was placed on sale at eight different places in the county for convenience of the farmers."

SAN MIGUEL COUNTY

County Agent Baldwin reports on the pest work in his county as follows:

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"Three pest districts for prairie-dog control were formed in the county during 1921. The thought in forming these districts was to make it so land owners, whose property lay adjacent to land in crops, could be asked to poison prairie dogs so crops could be saved. These three districts were formed with the idea that the dogs in their boundaries might be destroyed within a period of three years. The amount of poisoned oats distributed was 840 pounds. According to the average report of those who used this bait the amount of good realized was approximately $1.00 for each pound of poison oats used.

"Following is a newspaper report this office made on demonstration poisoning:

'SUMMER POISONING OF PRAIRIE DOGS SUCCEEDS

'Sometimes we hear the statement that it is useless to poison prairie dogs after June 1. However, an experiment in San Miguel County demonstrates otherwise. July 15 of this year there were, in the Norwood cemetery, 107 holes, most of which gave evidence of harboring rodents. Poisoned oats of like mix as was being distributed by the county extension office to farmers, was used about these holes. Approximately a teaspoonful of poisoned oats was placed near each rodent den at four different times, at equal intervals between the dates of July 15 and August 26.

'On September 1, the original 107 holes were covered with dirt. September 13 the covered holes were examined and it was found that only eight of the 107 holes had been opened and showed indications of habitation. It is thought that four of these eight holes contained badgers.

'The above shows that only approximately 4 percent of the prairie-dog holes were opened and no doubt a portion of the dogs inhabiting this 4 percent of the holes were poisoned, so that we believe it is accurate to state that in this case we disposed of approximately 96 percent of all prairie dogs which were present July 15 in the above plot, consisting of approximately two acres.

'Further there were but two dead prairie dogs found in the vicinity of where this poison was distributed. We, therefore, draw an added conclusion that the number of dead dogs found on top of the ground is no identification of the number which die from the effects of eating poisoned grain.'

"Conclusion: It is suggested that work be followed up in the districts already formed and an added attempt made to completely free the territory lying in this county between San Miguel River and Naturita Creek."

ARAPAHOE COUNTY

At a meeting held early in January at Littleton, the commissioners appointed Mr. A. H. Tedmon county pest inspector. They also agreed to furnish Mr. Tedmon a deputy to assist in the work. Mr. S. J. Hanks, of Deer Trail, was appointed. The commissioners also set aside a revolving fund of $1,000.00 to purchase poison supplies and take care of the non-resident land. We inspected three townships in the east end of the county with Mr. Hanks after the work had been done.

This section of Arapahoe County is very rolling, and had been heavily infested with prairie dogs. At the time of our visit, the prai-

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ries were green and the dog mounds very conspicuous. You could stand on a prominent point and see over a large scope of country, and as far as the eye could see was one continuous dog town. At this time this land is practically free of dogs.

County Pest Inspector Tedmon reports on the work in his county in part as follows:

"Our plan of work was to have the landowners do their own poisoning. The deputy and myself gave instructions and directions as to how the work should be done and did the final inspection.

"In the case where the landowners were non-residents or residents that did not comply with the order to clean up, the county, after expiration of the final date, did the work. In this case, we contracted this cleanup work to local men at a set price per acre. During the spring campaign, 5.37 tons of poisoned oats were used, and 650 pounds of carbon bisulphide. 18,560 acres of non-resident land, including some resident, were contracted and cleaned up by the county."

ADAMS COUNTY

Early in February a conference was held in Brighton with County Pest Inspector Robertson and his deputy, W. E. Denman. Plans were outlined for the season's work. The pest districts in this county were divided into three blocks. The time limit set for the land owners to complete the work of exterminating the prairie dogs was set in the three blocks thirty days apart.

The following extract is from Mr. Denman's report to the Adams County Farm Bureau:

"A meeting was called in each township and the people there assembled selected a man in each corner of the township as a crew leader, he having jurisdiction over nine sections, with instructions that when the time limit expired and no work had been accomplished, he was to take a crew and clean up all infested land under his control. For the labor, he and his crew were allowed 40c per hour. Each man in charge made a report of labor and poison used on each quarter section.

"In compiling the records we find that 300 non-resident land owners own 72,400 acres of land that was worked at a cost of labor and poison of $5,416.16, or a little over 7 1-2c per acre."

County Pest Inspector Robertson reports 900 farms involved in the rodent campaign, composed of 276,480 acres, using 16,360 pounds of poison.

WELD COUNTY

About 80 townships in Weld County are, or were, prior to 1921, heavily infested with prairie dogs. In addition to these townships, a number have a small infestation. Also a few scattering dogs are to be found on dry knolls or high ridges in or near some of the more thickly settled districts.

In 1921, a systematic campaign for prairie-dog control was started in Weld County, with the cooperation of the county commissioners and Mr. Mason E. Knapp, County Extension Agent. Mr. Knapp was appointed county pest inspector, and arragements were made with Mr.

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POISONED GRAIN PREPARED DURING 1922

Counties	No. gals. of poisoned grain shipped from Ft. Collins Lab.	No. gals. of poisoned grain prepared locally from supplies furnished by Ft. Collins Lab.	No. gals. distributed by Biological Survey for Government land.	Total
Adams	26	4,090	....	4,116
Arapahoe	79	3,248	....	3,327
Archuleta	18	....	....	18
Baca	15	....	....	15
Boulder	96	....	....	96
Bent	46	....	....	46
Chaffee	22	....	....	22
Conejos	77	....	450	527
Crowley	....	....	5	5
Costilla	130	....	....	130
Custer	283	....	....	283
Cheyenne	27	....	....	27
Delta	34	180	100	314
Douglas	....	295	12	307
Eagle	75	....	....	75
El Paso	16	450	....	466
Elbert	34	675	....	709
Fremont	8	1,373	754	2,135
Grand	11	225	....	236
Gunnison	215	....	....	215
Hinsdale	21	....	....	21
Huerfano	....	495	....	495
Jackson	5	....	....	5
Jefferson	6	....	....	6
Kiowa	16	....	....	16
Kit Carson	82	....	....	82
Las Animas	700	....	....	700
Logan	100	....	....	100
Lincoln	104	....	....	104
Larimer	63	....	....	63
La Plata	6	360	....	366
Montezuma	10	1,350	....	1,360
Montrose	16	1,080	174	1,270
Moffat	....	3,240	100	3,340
Morgan	202	....	....	202
Mesa	3	....	....	3
Mineral	....	....	400	400
Otero	145	....	....	145
Ouray	26	90	....	116
Pueblo	293	....	....	293
Park	3	....	....	3
Prowers	25	....	....	25
Phillips	5	....	....	5
Rio Blanco	15	....	....	15
Rio Grande	....	45	1,360	1,405
Saguache	....	45	400	445
San Miguel	....	54	....	54
Teller	33	....	....	33
Weld	6,056	3,840	15	9,911
Washington	227	540	....	767
Yuma	153	....	....	153
Grand total				34,972

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J. R. Lane to take care of the work in the field. Pest districts were organized as provided for by the Colorado Pest Act.

In 1922 the campaign was carried on under the same arrangement as in 1921, even more extensively than the previous season. New districts were organized, and the territory covered in 1921 was gone over again and all stray dogs taken care of. This was done before the work in the new districts was started.

On July 1, 1922, Mr. Knapp resigned and Mr. H. H. Simpson was appointed to fill the vacancy. Mr. Simpson has given us the same hearty cooperation as Mr. Knapp and has looked after the details of the work in a very systematic manner.

Too much credit cannot be given the commissioners of Weld County for their cooperation and financial backing of this campaign to remove one of the most serious problems that confronts the ranchmen of the dryland sections of this county.

Mr. Lane developed a system of work in the field which for effectiveness and personnel of crew was second to none in the State. Approximately 20 tons of poisoned grain were used in Weld County during the season of 1922. We quote the following from County Inspector Simpson's report for the year 1922:

"In 1921 five townships were cleared and this year practically fifteen townships have been cleared. This has made a tremendous showing, and at the present rate it should require only two more years to clean all prairie dogs from northern and eastern Weld County. This work has been kept in a solid block as much as possible, so there will be less infestation from adjoining townships while the work is in progress. At the present, there are petitions signed and in the hands of the commissioners for four more townships and two others have asked for petitions to circulate. A feature of the prairie-dog work that should not be lost sight of but credited to the good results being obtained is the elimination of a great many rattlesnakes. The losses of stock from rattlesnake bites are reported by stockmen in some localities as assuming large enough proportions to make it an important factor in reducing profits. Mr. Lane and his crew have adopted a rule to kill every rattlesnake they see, and the results this year show over one thousand snakes killed."

We have spent considerable time in Weld County this season, checking up results and we find that the work done by the individual ranchmen and Mr. Lane and his crew has been done in a very thorough manner. In fact, it is the cleanest, large body of land we have inspected in the State.

APIARY INSPECTION AND INVESTIGATION

By NEWTON BOGGS

The foundation of the apiary inspection is a law passed by the Legislature of 1913 and amended in 1921. The work has been conducted along the following general lines:

1. Demonstrations in the apiary. These were conducted to show better methods in the care of the apiary.

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2. Inspection of apiaries. This work was conducted in counties which requested it and where local inspection was provided.

3. Short courses, lectures and demonstrations were held during the entire season. These were conducted to show better preparation for apiary work.

4. Correspondence and literature. Special attention was given to many beekeepers in this way.

With the cooperation of the Extension Service of the Colorado Agricultural College and the county agents of Fremont and Logan counties, two demonstration apiaries were placed in each of these counties. This work consisted of a series of four lectures and demonstrations in each apiary. The attendance at each of these meetings averaged 15. The extent to which the influence of these meetings was felt in the counties is hard to estimate. In Fremont County the honey crop this year was a failure. However, the demonstration colonies produced approximately 50 lbs. apiece, which was left for winter. For the results of the Logan County demonstration, and a summary of other work done in that county, I will quote County Agent J. E. Morrison's report to the Extension Service.

"Beekeeping has been in years past a more or less "slip-shod," "hit or miss" affair in this county. A very few men have been in the honey business and have been more or less successful. Most of these men belonged to the Colorado Honey Producers' Association, which is a marketing organization. They had no local organization and their lack of cooperation had created more or less friction from time to time. There was also more or less American foul brood present at all times, as it was almost impossible to control it. The state apiary inspector, Mr. Newton C. Boggs, suggested that more could be done in the control of bee diseases by education than thru more heroic measures. A two-day school in beekeeping was accordingly arranged and put on March 15th and 16. In this school the subjects discussed had to do with the handling of bees and the control of disease. Arrangements were made at this school for conducting two demonstrations in beekeeping. The apiaries of Mr. P. N. Quist of the Iliff Community and Harry Pifer of Sterling were selected and the specialist actually manipulated four colonies of bees in each apiary. He visited these apiaries once each month and cared for the colonies.

"The results in these demonstration apiaries were most remarkable. The results were practically the same in each case so only one will be given Mr. Harry Pifer of Sterling had eleven colonies of bees at the start of the season. He handled all of his bees as near like the specialist handled the four demonstration colonies as possible. At the end of the season his eleven colonies had increased to twenty-seven, had made 1,056 pounds of comb honey surplus, and each of the twenty-seven colonies had forty-five pounds of stores for wintering. This is more remarkable when it is considered that the majority of the beekeepers were averaging about seventy-five pounds of extracted honey to the colony, or the equivalent of forty pounds of comb honey and their increase about five or ten percent.

"On August 29 the beekeepers of Northeastern Colorado held a field day. The morning session was held at the farm of P. N. Quist in the Iliff community. Mr. F. B. Paddock of Ames, Iowa, spoke on the subject, "Better Queens," and Mr. N. C. Boggs, State Apiary Inspector, discussed "Winter Care of Bees."

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"At noon a picnic lunch was served at Pioneer Park near Sterling. The beekeepers brought their families and a very enjoyable time was had.

"After lunch Mr. Paddock spoke on honey marketing and was followed by a round table discussion on beekeepers' problems. About 4:00 p. m. the meeting adjourned to meet in the evening at the county high school.

"In the evening two educational films were shown—"How Bee-Ware is Made" and "How Bees Live and Work." The films were followed by an illustrated lecture on the subject "Beekeeping in Iowa and Ontario," by Mr. Paddock.

"This was a most successful meeting and everyone felt well repaid for his time. The crowd, while not large, represented almost one-hundred percent of all the beekeepers in the county.

"At the close of the beekeeping school on March 15th and 16th, the beekeepers held a meeting and organized the Logan County Beekeepers Association. This association has been instrumental in securing a county appropriation for apiary-inspection work and also helped out on the field day above mentioned.

"This has been one of the most successful projects from every angle that has been conducted in the county this year.

It is hoped that the demonstration work may be continued next year."

BEEKEEPING REGIONS

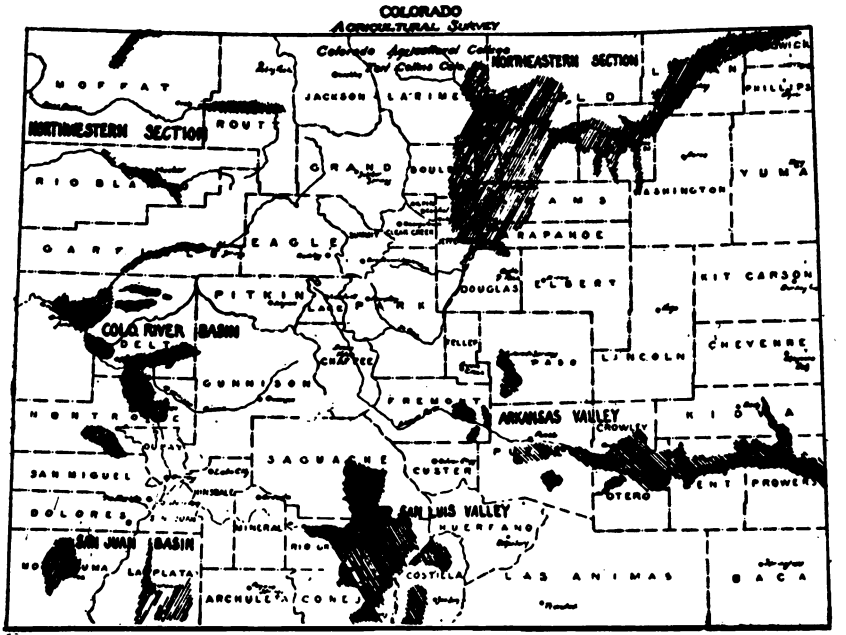

Fig. 13. Map showing beekeeping regions in State. Very few bees are kept in non-irrigated sections.

Very few bees are found in the non-irrigated sections of the State. Therefore, we divide the beekeeping part of Colorado into six regions.

First, the territory drained by the South Platte River and its

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tributaries. This section is well filled with beekeepers, excepting parts of Logan and Sedgwick Counties.

Second, the Arkansas Valley extending through the southern part of the eastern half of the State. A few of Colorado's most extensive beekeepers are located in this valley.

Third, the San Luis Valley, with an elevation of 7500 feet, a vast basin, the bed of an ancient lake, lying in the south central part of the State, almost wholly surrounded by mountain ranges. There probably are numerous localities here that would yield good returns from honey, as a considerable amount of alfalfa is raised for seed and sweet clover is found on waste places and seep land.

Fourth, the San Juan Basin having a considerable area of irrigated land in the river valleys, where alfalfa and sweet clover furnish abundant pasture for bees. Some high averages of honey production have been made in this region. The drawback is the rail transportation and marketing problem.

Fifth, the valleys of the Colorado, Gunnison, Uncompaghre and other rivers of the Colorado watershed, containing the principal fruit-growing areas of the State as well as a large amount of good beekeeping territory. A large number of colonies have been poisoned by fruit growers spraying while clover crops were in bloom. In some of these valleys we find the farmers cutting three crops of alfalfa, while within a half to a mile away on the mesas we find only two cuttings of alfalfa. This makes a continuous flow of nectar available nearly the entire season, as the crops on the mesas fill in between the flows of the valleys. This region produces between 35 and 50 cars of honey annually.

Sixth, the northwestern section of the State having few bees as it is undeveloped as yet on account of inadequate transportation.

LEADING BEEKEEPING COUNTIES

ARAPAHOE—In this county we find part of the holding of Herman Rauchfuss, the most extensive comb-honey producer in the United States. This shows the possible resources of this section. Mr. Rauchfuss has been operating here for a number of years and is one of the outstanding figures in American beekeeping.

LOGAN—In this section, beekeeping is relatively new. There are but few who have rather extensive holdings, the largest being 400 colonies. One party claims to make a substantial living from 250 colonies. He sells all honey locally and rather under price too. All interest in beekeeping is very recent. This past season the demonstration apiary work has been highly successful. There is no reason why this section could not be one of the most successful producing regions in the State. The meetings held were as complete as any in the State with a very high percent of attendance.

MESA—Nearly all of the meetings in the county have been held at Mesa, 35 miles from Grand Junction. There is no beekeeping of

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importance in the fruit-growing sections. The source of nectar on the mesa is alfalfa and sweet clover. In the uplands the alfalfa is allowed to bloom for two weeks sometimes. Usually very good crops are produced by those who give their bees reasonable attention. It was admitted by many present at the meetings that there are a large number of indifferent beekeepers and the average production for the region is very low. This locality could produce as much, if not more, than any in the State if attention were given to the essentials of management.

The beekeepers attending the meetings were very alert and especially so on the marketing problems. They have a local marketing association through which they ship their honey. They are very fortunate in having a good manager, Mr. S. B. Fralick of Debeque.

GARFIELD.—In this county, there is a very good association and they feel that their chief problem is that of marketing. The meetings give evidence that a great deal of trouble lies with the beekeepers. They make every attempt to grade up their honey and they are exceedingly jealous of one another. It seems to be next to impossible for beekeepers to get together for cooperation. It seems to be the practice to retail honey locally at wholesale prices. They are anxious to learn what the other counties have for a honey crop and plan to beat them to market.

This county is a wonderful place for honey production. The elevation is 5000 to 6000 feet, with alfalfa and sweet clover as the real source of honey. Most of the bees are located back on the mesas where alfalfa remains in bloom for a considerable period. A larger percent of comb honey is produced in this country than in any other. This honey does not grade what it should because most of the producers will not use top and bottom starters in the sections. The beekeepers in this county keep from 350 to 800 colonies each and the flow is such that large outyards are the rule. More attention has been given to modern methods of wintering here than in any other county. Many can see the advantage of winter protection, but as long as they can get such wonderful crops they will not make the expenditure necessary for winter protection.

DELTA.—Delta County is one of the largest producing counties of the State, but the industry has declined for several reasons. They have a local problem in the non-cooperation of the fruit growers, which is quite severe. The orchards are allowed to grow up with sweet clover, a principal source of honey. This plant is in full bloom when one of the sprays is given for the codling moth. The poison drips off the trees to the clover where it is gathered by the bees. Large apiaries have become extinct in seven to ten days. It seems that there should be better local cooperation.

The beekeepers of this county have large holdings, from 250 to 600 colonies. These people depend entirely on their honey for a living. Formerly many produced section honey, but during the war nearly

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everyone changed to extracted honey and few will ever produce comb honey again.

MONTROSE.—Montrose County is another of the large producing counties of the State. Most of the beekeepers here have large holdings and produce honey by the carload. They have a local association that has done much to stop the stealing of honey from the bees during winter. The beekeepers offered a liberal reward and caught and convicted two men of stealing honey.

LA PLATA AND MONTEZUMA COUNTIES.—This is said to be, and actually is, one of the best honey producing regions in the State. As yet, the industry is undeveloped on account of the transportation problem. In the two counties there are only about 6,000 colonies. This number could be increased considerably, as there is an abundance of sweet clover and alfalfa. The latter is allowed to bloom quite a while without cutting as most of the farmers have large acreages, being an extensive cattle and sheep country.

RIO GRANDE—As yet the beekeeping industry is in its infancy in this county. There are a considerable number of beekeepers keeping their bees by methods in use fifty years ago. Here we have the box-hive menace. Fortunately there has been no disease until this last year a few cases were found in the Del Norte section. A few men who had bees as a side line have averaged 100 lbs. per colony per year. One or two have better records than this. This shows what could be done in this valley.

FREMONT—In this county most of the beekeepers have very small holdings. The county does not seem to be conducive to honey production. The people are uninformed on methods of beekeeping management. The questions asked at the meetings show very clearly that the fundamentals are unknown. The county agent is much interested in improving the status of beekeeping. The foul-brood problem is serious in this county, but the fact that much interest is shown is evidence that they are alert and fighting the disease.

Beekeeping in this county cannot become extensive but can be made profitable as a part of the program necessary for the five and ten-acre tracts which make up the irrigated section.

PUEBLO—The beekeepers in this county do not have extensive holdings, the largest being only about 300 colonies. The honey producers have a good retail market in the city of Pueblo. Very little of their crop is shipped out. Mr. Harvey Said practices winter packing and as a result produces about twice the crop per colony that the other beemen do. Mr. W. L. Cooper, the county apiary inspector, has the foul-brood situation well in hand. Several of the largest beekeepers say they have not had a case of disease for three or four years.

CROWLEY—In this county, beekeeping has not been considered of any importance. There is one large beekeeper having about 800 colonies. The rest hold from 80 to 200. More are just getting started. Among the old beekeepers there is some disregard for recog-

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nized principles of successful beekeeping. However, their attitude is changing in that they are in a receptive mood and are willing to consider possible improvements. They are much concerned about disease which large producers feel is a necessary evil. Eight colonies were found affected with European foul brood, but the owner has burned everything that had any disease. This infection came from bees that were shipped in from Arkansas.

OTERO—In this valley there have been a good many large beekeepers but their holdings seem to have decreased for several reasons. The flood of 1921 caused a direct loss. They say beekeeping is less profitable than formerly, but they give no attention to stock improvement or better methods.

BENT—This section does not have many beekeepers, but they have quite extensive holdings and have been producing for a long time. Their crops average about 60 lbs. per colony. They dispose of a large amount of honey locally, to tourist trade and through mail orders. Most of the honey produced is extracted.

PROWERS—This county has always been a large producing section. There are some very extensive beekeepers and their crops have been very good. Alfalfa is the chief source of nectar, supplemented with sweet clover. The territory is capable of producing more honey, for as high as 150 colonies are kept in one apiary. The disease situation is very bad in some of the larger apiaries which have been somewhat neglected in the last three or four years.

EL PASO—This county is limited as far as honey production is concerned, as they have not very many acres of irrigated land. The honey produced here is not of the best quality because of the discolored nectar from the fall flowers. The beekeepers have an excellent market at a fancy price in Colorado Springs for more than they can produce.

JEFFERSON—Beekeeping in this county is not conducted on such an extensive scale as in many other sections of the state. The entire county is becoming interested in intensive operations altho 350 colonies comprise a large holding. The meetings held in this county were as good as any held in the State. The beekeepers are quite successful in marketing as most of them are members of the Colorado Honey Producers' Association. The beekeepers are interested in disease control and have taken definite steps to get an inspector appointed.

BOULDER—Beekeeping has been well established for a long time in Boulder County. There are quite a few beekeepers and most of them have quite extensive holdings. The production problem has been rather serious. The men have large holdings and many use poor methods of management, resulting in unprofitable production. A sixty-pound average per colony is normal for the county. They give no attention to queens or wintering and disease is played with.

LARIMER—In this county beekeeping has been conducted on quite an extensive scale. A good many have more than 600 colonies each.

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The industry is on the down grade. However, a few vocational men with training are starting in. Some of these men are going to make good beekeepers. The production is no doubt lower than in years past. No attention is given to methods of improving stock or management. Disease has established itself in some large apiaries and unless the owners use more precaution, they will be out of the business in a few years.

WELD—Weld County has more bees than any other county because it has the largest acreage of irrigated land. The marketing situation has been worked out by one large beekeeper who sells his entire output from 700 colonies at retail for a better price than any of his neighbor beekeepers. This is accomplished by advertising, putting up a neat package and having honey on hand the entire year. There is some disease in this county but it is under control.

The Extension Service of the Agricultural College secured the services of F. B. Paddock, State Apiarist of Iowa, during the month of August. Mr. Paddock addressed the beekeepers in nearly every beekeeping county in the State and emphasized the importance of better queens, better methods of marketing and better methods of management. His talks were well received.

My work has been greatly facilitated and made more effective by the cooperation of the county apiary inspectors, county agents and the Extension Service of the Colorado Agricultural College.

BEEKEEPERS ASSOCIATIONS

County—	Secretary	Address
Larimer	Russell Robinson	Fort Collins
Boulder	County Agent	Longmont
Arapahoe	A. J. Critchfield	Byers
Logan	J. E. Morrison	Sterling
El Paso	Herbert E. Webb	Colorado Springs
Pueblo	W. L. Cooper	Pueblo
Bent	W. H. Birney	Las Animas
Prowers	E. C. Polhemus	Lamar
Fremont	County Agent	Canon City
Rio Grande	Carlos A. Wolfe	Monte Vista
La Plata	Lloyd B. Mason	Durango
Montezuma	Dr. R. W. Calkins	Cortez
Montrose	J. C. Matthews	Montrose
Delta	M. P. Weeks	Delta
Mesa	S. B. Fralick	Debeque
Mesa	Jas. A. Greene	Grand Junction
Garfield	J. D. Caldwell	Rifle

LIST OF COUNTY APIARY INSPECTORS:

County—	Inspector	Address
Adams	Walter Martin	Brighton
Bent	W. H. Birney	Las Animas
Boulder	F. C. Hilker	Boulder
Crowley	Frank E. Gray	Ordway
Delta	Roy Adams	Delta
El Paso	C. A. Crane	Colorado Springs

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Fremont	J. I. Mayhew	Florence
Garfield	F. W. Neubauer	Newcastle
Larimer	W. C. Evans	Fort Collins
La Plata	R. L. Pennell	Ignacio
Logan	A. G. Turner	Sterling
Mesa	Wm. Harkleroad	Fruita
Montrose	C. E. Kendle	Montrose
Otero	V. O. W. Hopper	Rocky Ford
Pueblo	W. L. Cooper	Pueblo
Rio Grande	Edward Haefeli	Monte Vista
Weld	N. L. Henthorne	Greeley

SUMMARY OF WORK DONE:

No. of lectures (not including two-day schools)	64
No. of two-day schools held	12
Average attendance at meeting	20
No. of county associations organized	18
Total number of apiaries inspected	173
Short Course of one week at Grand Junction, average daily attendance	47

WEED CONTROL

By W. L. May

The work of the 1922 season on weeds was of two phases, first, continued observation on the condition of the whorled milkweed plots treated with chemicals in 1920 and 1921; and second, investigational work on the control of the wild morning glory and perennial peppergrass.

Whorled Milkweed

Plots treated in 1920 and 1921 (see twelfth and thirteenth annual reports of the State Entomologist) were closely observed throughout the 1922 season, and the results showed that this pest could be eradicated by the use of sodium arsenite solutions applied in the form of a spray. It was evident that two applications of the chemical during the season gave the best results. The strength used was a dilution of 1 to 20 or 1 to 32 of an original solution containing 8 pounds of white arsenic per gallon. The first application was made in June when the plants were about six inches high, and the second in August when the returning growth was just beginning to show blossoms.

Inasmuch as it appeared that the investigational work has established the methods by which the milkweed could be controlled, the next step in the work was to get the information obtained into the hands of those farmers who could use it. This is being done in two ways. First, the information is being given directly to farmers with whom the field men of the office come in contact during the field season; and second, a complete report of the experimental work on this pest. with a detailed discussion of the results of this work has been made in Bulletin 285 of the Colorado Experiment Station. The work was published by the Experiment Station because by so doing better distribution of the bulletin could be obtained throughout the State. The bulletin covers

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not only the results of the chemical work on the control of the milkweed, but also gives a report of the work done and the results obtained in determining a cultivation method of controlling the plant.

In connection with the chemical work on the killing of the milkweed, there were some rather interesting observations with reference to the use of chemicals as weed killers in the arid sections. A discussion of these observations is contained in Bulletin 285.

INVESTIGATIONAL WORK

This work was confined to experimental investigation on the control of two bad weed pests, wild morning glory *(Convolvulus arvensis)*, and perennial peppergrass *(Lepidium draba)*.

WILD MORNING GLORY

The experimental work on this pest was a continuation of the use of sodium arsenite in different strengths and at different seasons; and in addition, some plots were treated with carbon bisulphide.

SODIUM ARSENITE SPRAYED PLOTS—In all, 30 square-rod plots were treated with this chemical. These plots were divided into series lettered B. D, E. F and G, according to the strength of solution used. The stock solution used was Ussco Brand sodium arsenite weedkiller, containing 8 lbs. white arsenic per gallon. The following table gives amounts used per square rod for the different series:

Series B—1 pint Weedkiller plus 5⅞ gallons water
Series G—5 pints Weedkiller plus 9⅝ gallons water
Series E—½ gallon Weedkiller plus 5½ gallons water
Series D—1 quart Weedkiller plus 5¾ gallons water

In addition to the sodium arsenite, a small quantity of lime caseinate was added to each application, to serve as a sticker and spreader. This material was very satisfactory for this purpose.

The applications were made in the form of a fine mist with a Meyers hand spray-pump, and all parts of the tops of the plants were thoroughly wetted.

In every instance the tops were entirely killed but growth returned much more rapidly and heavily on the plots treated with the weaker solutions.

No definite data on root killing can be obtained until next year.

Complete records have been kept on the treatment of each plot, and the plots are all mapped. Next year's observations should indicate whether or not this method of treatment is at all promising. In addition to the data on actual killing of the pest, some detailed study should be made as to the effect upon the soil due to the application of the arsenical.

A small plot was also treated with Weedicator "Sureshot" Weedkiller manufactured in Los Angeles. The killing of the tops was quick and effective, but no definite information as to its root-killing power is yet available.

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PLOTS TREATED WITH CARBON BISULPHIDE—This chemical, as well as sodium arsenite, has been recommended in California for killing the morning glory. During 1922, twenty-two plots were treated with carbon bisulphide. The carbon bisulphide was furnished gratis by Wheeler, Reynolds and Stauffer of San Francisco, this office paying the freight charges.

Method of Application—The carbon bisulphide was applied in holes made with a five-eighths-inch bar, driven in with a sledge. The depths of holes were 12-inch and 18-inch in two different series. In each of these series, there were three different spacings of the holes used. These spacings were all in the form of equilateral triangles. In the first group the equilateral triangles were 3½ feet on a side; in the second group, 4 feet, and in the third group 5 feet. This gave 27, 18 and 10 holes, respectively, in plots 15 feet square.

In the first group, 3½ ounces of carbon bisulphide were used per hole; in the second group, 4 ounces, and in the third, 6 ounces.

Results—This material proved very erratic in its action. In some instances, the morning glory was apparently entirely killed and in others, under very similar conditions, no ill effects whatever were noted. The determining factor seems to be largely the porosity of the soil. The condition needed is one which allows of free circulation of the fumes through the soil and yet does not allow too fast escape into the air. Heavy soil will allow poor permeation and wet soil practically none at all.

There are still on hand about 200 pounds of carbon bisulphide with which to continue this work next year.

PERENNIAL PEPPERGRASS

This pest is a menacing problem in that section of the San Luis Valley immediately around La Jara. There is one field of 60 acres just west of La Jara that is completely taken with the pest and many more fields there are badly infested. The plant has resisted all methods of control used in this section.

Actual work done by this office is very meager. The only experimental work done was the spraying of two plots on the farms of Harry Weist and J. M. McKelvey, with sodium arsenite. The remainder of the work consisted in getting data on the habit of the plant and in suggesting methods to be pursued by interested parties whose land is infested. Following is an outline of the work to be undertaken by different farm-owners in the San Luis Valley during the season of 1922 in an effort to determine a practical method for eradicating the perennial peppergrass.

METHOD NO. 1, J. M. MCKELVEY, COOPERATOR—This method is to be carried out on an infested piece of land just east of the corrals on McKelvey's place west of LaJara. The land will be left untouched until the peppergrass is nearly ready to go to seed. Then the land will be plowed and clean fallowed during the remainder of the season. This clean fallowing can probably best be carried out with a sharp disc

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which will cut the plants which may show up to a depth of 4 or 5 inches into the ground. The effort will be made to keep the plant from showing any growth during the remainder of the season. This plot will be plowed as late as possible in the spring of 1923 so potatoes can be planted and matured for the 1923 season.

METHOD No. 2, J. M. MCKELVEY, COOPERATOR—This will be carried out on the same piece as the above, method No. 1, the same treatment being given until the time for planting fall wheat, which will probably be in late August or early September. The plot will then be sowed to winter wheat, and in 1923 will be plowed following the harvesting of the wheat, and fallowed in 1923 preparatory to planting potatoes in 1924. It is generally believed that winter wheat will not make a crop in the Valley, but by planting a little early and giving it a good start with irrigation, it is felt that the chances are good for securing a crop, and this method will start returns coming from the land sooner than if it is clean fallowed throughout the season and put to potatoes the following year.

METHOD No. 3, HARRY WEIST, COOPERATOR—This work will be done on the land lying just north of Mr. Weist's house. The plant will be left alone until early seeding time, and will then be plowed and planted to barley and peas to be used as a forage crop.

METHOD No. 4, HARRY WEIST, COOPERATOR—The field used here is a field north of Mr. Weist's house that was plowed on June 6, 7 and 8, and sowed to barley. On a portion of this field the barley will be cut early and used for hay. Then the ground will be plowed and sowed to winter wheat.

METHOD No. 5, W. L. FENIMORE, COOPERATOR—Mr. Fenimore plans to plow up a bad patch of peppergrass late in the summer and allow it to lie rough over winter. In the spring of 1923 the ground will be plowed again and planted to potatoes.

The perennial peppergrass problem is important enough that considerable time and earnest effort can well be spent on it. It is felt that the methods outlined above not only give promise of getting rid of the peppergrass, but will also give an early crop return from the ground treated.

It is not known just how far the above plans were carried out, but a check should be made on this next year to determine results.

FINANCIAL STATEMENT

There being no receipts to account for during the year, the financial statement consists entirely of disbursements, which are as follows:

State Entomologist Fund—Salary of State Entomologist	$	499.92
Salary and per diem of Deputies, traveling, incidental and office expenses		14,445.26
Total	$	14,945.18
Pest Fund—Salary of State Entomologist	$	499.92
Per diem and expenses		4,496.22
Total	$	4,996.14
Apiary Inspection Fund—Per diem of Deputy, traveling and incidental expenses	$	2,989.60

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Circular 39 October, 1923

Revision of Circular 35

SOME COLORADO FARM PESTS

WITH SUGGESTIONS FOR THEIR CONTROL

By W. L. BURNETT

Office of State Entomologist
COLORADO AGRICULTURAL COLLEGE
Fort Collins, Colorado.

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W. L. BURNETT ---------- Deputy, Rodent Control
NEWTON BOGGS ---------- Deputy, Bee Inspection
J. H. NEWTON ---------- Deputy Alfalfa Weevil Control
W. L. MAY ---------- Deputy, Weed Control
WM. P. YETTER, JR. ---------- Deputy

This circular is issued to take the place of Circular 35, issued in June, 1922, which is practically exhausted. In the language of the commercial world, Number 35 has been our "best seller." We have received more requests for it than for any other we have published on rodents.

This circular not only contains all the information found in Number 35, but additional information which brings the subject up to date.

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SOME COLORADO FARM PESTS

WITH SUGGESTIONS FOR CONTROL

By W. L. Burnett

Early settlers in Colorado, as well as other western states, found the country inhabited with various forms of wild life. Prairie dogs, ground squirrels and other rodents had their under ground burrows in the choicest grazing land, while predacious mammals roamed freely over mountain, plain and valley. These predacious mammals fed on the rodent population and were Nature's provision for keeping in check undue increase in these forms of mammalian life.

Raptorial birds, hawks and owls, also fed extensively on rodents. With the coming of the settlers. conditions were changed. Hawks and owls were killed by the hundreds, because tradition says they are enemies of barnyard fowls. Later on, the extermination of the predacious mammals was started, and is now going on as rapidly as possible, a procedure we are not wholly in sympathy with.

With the raptorial birds reduced to a minimum, and the total extermination of predacious mammals in sight, we are now facing the problem of rodent control for the protection of farm crops and pastures from a new angle, namely, mechanical control.

In former years, when the range was open, there was forage enough for both cattle and rodents, but at the present time. conditions are different; this vast open range is almost gone. The fight is now on to see which will get the grass first, the rodent or the cattle, on what is left of the range. The settler who is now farming this land, besides drought and wind to contend with, must also fight the rodents.

It is true in the irrigated section, the prairie dogs have been driven to the higher ground, and under these conditions are increasing, unless artificial means have been taken to reduce their number. It is also true that on the irrigated land, ground squirrels, field mice, and pocket gophers, are finding conditions ideal for increasing in numbers.

With the facts facing us that the annual loss from rodent pests alone, in Colorado, cannot be computed in thousands but in millions of dollars, it is very important that the best possible methods for control must be placed in the hands of the ranchmen of the State, so they may combat these pests in an intelligent manner.

FORMULA FOR RODENT CONTROL

After several years of experiments, the office of the State Entomologist and Colorado Experiment Station, co-operating, have developed a formula known as Colorado Formula No. 46, for the control of prairie dogs, ground squirrels and kangaroo rats.

The formulas used in former years were only effective at certain seasons of the year, before green food was available, but grain prepared with our formula No. 46 may be used at any season of the year when the rodents are active, and regardless of the supply of green food.

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COLORADO FORMULA NO. 46

Oats	14 quarts
Strychnine (Alkaloid powdered)	1 ounce
Saccharine	⅛ ounce
Flour	¼ pint
Baking soda	1 ounce
Fine salt	½ pint
Petrolatum oil	¼ pint
Water	1 pint

Dissolve strychnine in one-half pint of cold water, then add one-half pint of warm water. Stir in soda and saccharine, add salt and oil, put over fire and heat until salt is dissolved, stirring constantly. Remove from fire, stir in flour, making a creamy paste. Pour the poisoned solution over the grain and thoroughly mix. When mixed, the grain is ready to use.

As the poisoned solution with which the grain is treated in our formula is in the form of a paste, it is very essential that some measure be taken to prevent the dusting off of the poison. After experimenting with glycerine, gelatine and other materials without obtaining the desired results, we turned our attention to mineral oils, and in petrolatum oil we found the ideal substance. It is tasteless and odorless, and meets all the requirements of a prevention against dusting. Not only does the oil prevent dusting, but the grain retains a small amount of oiliness, which seems to appeal to the rodent's taste.

Poisoned grain treated with this oil, remains fresh for greater length of time than grain treated with any other formula we have tried.

In the directions for preparing grain with our Formula No. 46, we say, "Dissolve the strychnine in water." The word "dissolve" is a misnomer, but is used in lieu of a better one. What really takes place is, the strychnine by constantly stirring until the flour begins to thicken is held in suspension.

Directions for using this poisoned grain for prairie dog control are as follows: The amount of grain to be used is about one teaspoonful, or what may be picked up between the four fingers and the thumb. The grain should be thrown against a hard surface of the ground, on the outside of the burrow, about a foot from the opening. The grain should be scattered enough to prevent stock picking it up.

The first time over the ground it is very important that every burrow be treated, regardless of whether it shows signs of being inhabited or not. On going over the ground the second time it is only necessary to treat the burrows that show signs of life, but the time between the first treatment and the second should be at least two weeks.

The advisability of early spring poisoning on the plains depends largely on climatic conditions, relative to temperature, storms and high winds, as it is not advisable to put out poison unless weather conditions are such that all the dogs are active.

It is not advisable to start poisoning campaigns in the western and southwestern parts of the state, where the prairie dogs hibernate

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throughout the winter months, before April 1st, as the process of coming out of the hibernating state is drawn out for a week or two, and while some dogs may be seen out as early as the last week in February or the first week in March, not all the dogs are active at these times.

These are not hard and fast rules, and you should be governed by location and seasonal conditions.

These directions will also apply to the Wyoming ground squirrel found in the northwestern part of the state. If you wish success in the use of this grain, follow the directions carefully. Grain thrown down in the burrow is usually wasted.

Oats prepared according to Formula No. 46 are carefully mixed at our laboratory, at the State Agricultural College. We have all the necessary utensils for preparing the poisoned solution in a thorough manner, and the mixing is done in a large revolving barrel churn, which insures an even coating of all the grains.

This prepared grain is sold to the farmers at cost of the ingredients and overhead expense. On account of purchasing our supplies in large quantities, we can probably furnish this grain cheaper than you can prepare it yourself.

The prepared grain we have for sale is put up in one, three, five, ten and fifteen gallon bags. We do not quote prices in this circular, as they change from time to time. A postal card will bring you the latest price list.

We suggest that communities pool their orders so as to save express charges, as poisoned grain is not mailable.

FUMIGATION FOR RODENTS

Certain gases may be used successfully for ground squirrel and prairie dog control, provided the soil is full of moisture so as to prevent the escape of the gases.

Carbon bisulphide.—To use this gas take any absorptive material, such as dry horse-manure, corn cobs, or cotton waste, pour on a large tablespoonful of crude bisulphide, throw it as far as possible down the burrow, quickly close the hole with earth and tamp it with the foot so as to prevent the escape of the gas.

Warning: Carbon bisulphide is inflammable and highly explosive. Do not open it near a fire or where anyone is smoking. Do not use a stone to stop the opening of the burrow, as you are apt to strike it with the shovel when throwing on the dirt and the sparks may ignite the gas and cause it to explode. Carbon bisulphide should be kept tightly corked, as it evaporates rapidly on exposure to the air.

Pintsch Oil.—From what experience we have had, and from reports of ranchmen who have used this gas, we have no doubt it can be used under certain conditions with satisfactory results. We are of the opinion that this gas does not run even, so that one gallon may be used with perfect success, while a gallon from another lot may be

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used with indifferent results. It is applied the same as carbon bisulphide, but use two tablespoonfuls in place of one of bisulphide to each hole. The same precautionary measures should be taken in the use of this gas as in the use of carbon bisulphide.

Aero Brand Gas Flakes.—There has recently been placed on the market by the "Acme Fumigating Corporation" a thin bluish-black flake, that decomposes on exposure to moisture, with calcium cyanide as the active ingredient. The directions for using these flakes as given by the manufacturers are as follows:

> **"An iron spoon, long handled, of a size sufficient to hold the required dosage, is the only instrument used in application.**
>
> **"By such means, 2 or 3 ounces of gas flakes are introduced as far within the burrow opening as they may be conveniently placed."**

The party that wrote the above directions was not acquainted with our plains and rattlesnakes, or he would not have advocated introducing a spoon with the hands down the burrows. We use a funnel with a spout 36 inches long and 1¼ inches in diameter.

We have tried out these gas flakes on a small scale for prairie dogs and the plains pocket gopher. From what experience we have had, we concluded that these gas flakes are not effective for the control of our plains pocket gopher. This is also true of carbon bisulphide, as the gophers seemingly block their runways against gas.

We have tried out the Aero gas flakes a number of times for gopher control, placing two ounces of the flakes in the runways every few feet, and on checking up results, we found the gophers as active as before treatment.

For prairie dogs, we believe that in non-porous, moist soil, Aero gas flakes may be used successfully. We do know that the flakes are decidedly more pleasant to handle than carbon bisulphide.

On the following pages you will find brief discussions and suggestions for control of the following rodents and birds:

Prairie dogs
Ground squirrels
Pocket gophers
House rats
House mice
Rabbits
Kangaroo rats
English sparrows
Pinon jays

PRAIRIE DOGS

Three species and one subspecies of prairie dog occur in Colorado as follows:

Plains Prairie Dog, *Cynomys ludovicianus ludovicianus.*
White-tailed Prairie Dog, *Cynomys leucurus.*
Gunnison Prairie Dog, *Cynomys gunnisoni gunnisoni.*
Zuni Prairie Dog, *Cynomys gunnisoni zuniensis.*

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The distribution as given here varies somewhat, but will serve our purpose in this circular.

From longitude 105 degrees west, east to the Nebraska-Kansas line, occurs the Plains prairie dog, *Cynomys ludovicianus ludovicianus.*

The White-tailed prairie dog, *Cynomys leucurus,* occurs in Jackson, Routt, Moffat, Rio Blanco, Mesa, Delta, Eastern Montrose and Ouray counties.

The balance of the infested territory is inhabited by the Gunnison prairie dog, *Cynomys gunnisoni gunnisoni,* and its subspecies the Zuni prairie dog, *Cynomys gunnisoni zuniensis.*

Hollister, (N. A. Fauna, No. 40) gives the distribution of the Zuni prairie dog in the State as follows: "Southwestern Colorado, north in Western Colorado to Montrose County."

He lists specimens from the State from the following localities: Cortez, Montezuma County; and Coventry, Montrose County.

Statements are often made by ranchmen and others that prairie dogs raise more than one litter in a season, but we have no evidence to substantiate these statements. From records we have in the office of the State Entomologist, the young of the plains prairie dog are born during the month of April and possibly the first part of May. The number of young varies from three to six.

The breeding season may extend over a period of three or four weeks. In a number of gravid females examined on the same date, the size of the embryos varied from that of a currant to that of an English walnut.

Prairie dogs are too well known to require description. Like the buffalo and antelope, they are closely associated with the early history and traditions of the West from the time of the earliest explorers. The buffalo are gone, antelope are going fast, and, some day, "finis" also will be written for the prairie dogs. These rodents also figured in the early literature of the great plains. Early writers drew on their imagination and wrote of vast prairie dog villages with a perfect system of well-laid-out streets, and of prairie dogs, rattlesnakes and owls, not only living together in the same villages, but occupying the same burrows in perfect harmony.

The plains, Gunnison, and white-tailed prairie dogs may be successfully controlled with our formula Number 46, at any season of the year when they are active.

The Zuni prairie dog of the southwest presents one of the hardest problems in rodent control with which we have to contend. While it is only a sub-species of the Gunnison dog, its food habits seem to be quite different, at least so far as taking poisoned grains is concerned. Some times it will take poisoned grain very readily, and at other seasons will refuse to eat even unpoisoned grain.

It is possible that in the locality inhabited by the Zuni dog in this State, there is a plant or plants that the dogs prefer to grains, and seasons when they refuse to eat grains are seasons when conditions are right for the development of these food plants.

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WYOMING GROUND SQUIRREL

Citellus elegans

This is the ground squirrel of the northwestern counties of the State, where it is commonly called "gopher." and is the most serious mamalian pest the ranchmen have to contend with in that section. It is also called picket-pin gopher, gray gopher and whistling gray squirrel.

The Wyoming ground squirrel is about two-thirds the size of a prairie dog, with a short tail, more or less bushy. General color is brownish.

It adapts itself to varied environmental conditions, making its home on the hillsides, in meadows, along the roadside and on ditch banks, and is not readily driven out by irrigation.

It is a prolific breeder, with one litter a season. The young vary in numbers from one to eleven, averaging 6.6 in the 44 females examined.

This squirrel is active only about five months in a year. The balance of the time it is in a state of aestivation or hibernation. This period of inactivity varies to a considerable extent in different localities in the State. The invasion of the plains region by this squirrel is of recent date, and we wonder what the outcome will be. It is hardly possible, with our present knowledge of its habits and methods for control, that it will overrun the highly cultivated section of northern Colorado.

On account of the economic importance of this rodent as a farm pest, it is advisable to give more detailed information than was given in Circular No. 35.

The distribution of this ground squirrel in the State is continually changing, as new territory is being occupied each season. Two counties, Lake and Park, are infested for the first time this year, which brings the total number of counties infested to fourteen. From records in the office of the State Entomologist, the distribution of this squirrel by counties is as follows: In Jackson County, it is distributed over practically the entire county outside the low lands along the rivers and creek bottoms. We have records of its occurrence at Walden, Cowdrey, Owl, Hebron, Spicer and Rand.

The squirrels are found in Routt County in the Bear and Elk River Valleys and the valleys of the smaller tributaries of these streams. It has been reported from Columbine, Hayden, Trull, Pool, Dunkley, Oak Creek, Phippsburg, Yampa, Egeria, Steamboat Springs and Deep Creek.

In Moffat County the squirrels occur from Craig westward, down Bear River Valley to Lily P. O.; from Maybell south to the Danforth Hills, in the Axial Basin, in the open country between Williams River and Deer Creek; north from Craig up Fortification Creek to Little Bear Creek, and from Lay north to the county line. Lily P. O. is our most western record in this county.

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In driving across Moffat County in July, 1923, the squirrels were common to Lay. After leaving Lay they were not so common. By the time Sunbeam was reached only a few were to be seen. None were seen from Sunbeam to State Bridge on Little Snake River. We also failed to find them in Lily Park.

The squirrels are not uncommon on White River, Rio Blanco County, in the vicinity of Meeker and south from Meeker to Rio Blanco P. O.

In Eagle County they are distributed pretty well over the entire county, except the higher mountain portions. They are recorded from Burns, Gypsum, Eagle, Ortega, Sherwood, Wolcott, Edwards, Avon, Minturn and on Sheephorn and Brush Creeks.

In Grand County they are found at Granby, Hot Sulphur Springs, Martin, Radium and Kremmling.

In Township 5 South, Range 58 West, Summit County, they are found along the Blue and Snake Rivers and Ten-mile Creek.

In Clear Creek County, the squirrels occur west from Empire up Clear Creek Canon some five or six miles, then east to Idaho Springs and South to Georgetown. The ranchmen state that the first squirrels in Clear Creek County were a pair brought in as pets, and later liberated. I heard the story at Empire when in the County in 1913. Mr. McCampbell, of this office, was told the same story at Dumont in 1923. The story goes that they were brought in from Texas, but as this squirrel does not occur in Texas, no doubt they reached this county via Berthoud Pass, as they came via Tennessee Pass into Lake County.

In Garfield County they are found along the northern boundaries, and in the vicinity of Carbondale up Cattle Creek, and on Missouri Mesa.

In Pitkin County the occur from Sloss to Thomasville, along Frying Pan Creek.

In Larimer County they are found along the northern tier of townships east to Weld County, south to Cherokee Park and Glendevey on the Larimer River, and at Log Cabin, Elkhorn, Rustic, and in Estes Moraine and Horseshoe Parks, and down the Big Thompson Canon to Township 5 North, Range 71 West. They are also in the upper Buckhorn Valley, and within a mile of Waverly in Township 10 North, Range 69 West.

In Weld County they occur only in the south half of Township 12, Ranges 65, 66, 67, and Township 11, Ranges 65, 66 and 67.

The Wyoming ground squirrel was first reported from Lake County at Malta in the spring of 1923, by Mr. Joseph Keyes of the U. S. Biological Survey. Later in the season we found them not uncommon in Township 11 South, Range 80 West, about five miles above the Chaffee County line, near the D. & R. G. station Keco.

In August, 1923, Mr. S. C. McCampbell, from this office, found the squirrels not uncommon in the vicinity of Alma and Fairplay, Park County.

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We have always been able to successfully control these squirrels with our formula No. 46, at any season of the year when they were active, no matter how abundant other foods were. However, in the past year or two, there has been introduced into the squirrel territory a new food plant very much to their liking, namely, head lettuce. The squirrels are very fond of the tender leaves of this plant, and we were somewhat pessimistic as to what results we would have in the use of poisoned grain around the lettuce fields. Reports received this season indicate that our fears were groundless.

Some lettuce growers in the vicinity of Granby, Grand County, do not attempt to poison the squirrel burrows, but scatter the poison around the lettuce fields, putting a teaspoonful about every ten feet, and they report the best of results.

STRIPED GROUND SQUIRREL

Citellus tridecemlineatus pallidus

This squirrel is known locally as "gopher" and "striped gopher," and is found in the plains regions of eastern Colorado. It occurs sparingly in the eastern foothills up to about 9,000 elevation, and

Fig. 1—Striped Ground Squirrel *Citellus l. pallidus*. From a specimen taken at Fort Collins, in May. Original. M. A. Palmer, Delineator.

in Jackson County, west of the Medicine Bow Range. In Moffat, Rio Blanco and Garfield Counties, and in most of the San Luis Valley, this ground squirrel is replaced by the smallest member of this group, *Citellus tridecemlineatus parvus*.

The food of this squirrel consists of seeds, grain of all kinds, grass and grass roots, but it has a decided preference for corn, especially where newly planted, which it digs up by following the planted rows. It also feeds on grasshoppers and other insects. The greater damage done by this ground squirrel is in the cultivated fields, as the damage done on pasture land cannot be very great, for, unlike the prairie dog, it destroys only what it eats. Around the prairie dog holes, the grass is always killed for several

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feet, but not so with this squirrel. You will often find the grass up to the mouth of the holes, making them, at times, difficult to see.

The striped ground squirrel presents an economic problem that is somewhat difficult to solve. It is, no doubt, a pest in the dry-land sections, and the damage done to crops is very noticeable. On the other hand, damage done in the irrigated districts is not so noticeable, and from our observations and examination of stomachs, the food in these sections consists largely of grasshoppers and other insects, as first reported by C. P. Gillette, in Bulletin 6 of the Iowa Experiment Station for that state.

Much of the damage to crops attributed to this squirrel in the regions adjacent to the foothills is done by that foreign invader, the ring-necked pheasant.

This ground squirrel may be successfully controlled with our formula No. 46. If one prefers, he may substitute whole corn in place of oats.

ROCK SQUIRREL

Citellus variegatus grammurus

The rock squirrel is the largest and has the longest tail of any of the ground squirrels that occur in the State. In a general way, it resembles the eastern gray tree squirrel. It makes its home among the rocks, in stone fences, and in underground burrows. It is found along the eastern foothills, from the southern border north to near the Wyoming line. On the Western Slope, it occurs as far north as Garfield County, and west to the Utah line.

Its food consists of seeds of various kinds, apples, cherries, apricots, chokecherries, blackberries, acorns, squash and melons. It also eats garden peas and grain of all kinds. It is very fond of the pits of the apricot and cherry, and has been known to cause considerable damage in orchards where these fruits are grown.

It climbes trees readily, a habit that, to our knowledge, no other member of the *Citellus* group of ground squirrels in Colorado has.

For control measures, by substituting corn for oats, our Formula No .46 has been used successfully. We have also used cherry pits instead of oats with good results. No doubt apricot pits and acorns from the scrub oaks may be used with success.

KANGAROO RATS

Other names: Field rats, sand rats, pinto rats.
Four forms of Kangaroo rats occur in Colorado:
San Luis Kangaroo Rat, *Perodipus ordii montanus;*
Richardson's Kangaroo Rat, *Perodipus ordii richardsoni;*
Moki Kangaroo Rats, *Perodipus ordii longipes;* and
Wyoming Kangaroo Rat, *Perodipus ordii luteolus.*

Wherever sandy soil and suitable conditions exist in the State one can usually find kangaroo rats in more or less abundance. From

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our present knowledge, they reach the height of their abundance in the San Luis Valley, the Arkansas Valley south of the river, and along Big Sandy Creek in Eastern Colorado.

Kangaroo rats are nocturnal and prefer moonlight nights for their frolics.

Their homes are usually along the fences and ditch banks. In some sections they honeycomb the ditch banks with their burrows

Fig. 2—Kangaroo Rat (*Perodipus richardsoni*). Original in Circular No. 25, Office of State Entomologist, M. A. Palmer, Delineator.

to the extent that the banks must be repaired each spring before they will hold water.

Kangaroo rats are fond of grain and seeds of all kinds, and in the fall store large quantities of available food. They are easily controlled with poisoned grain prepared from our Formula No. 46. The poisoned grain should be placed in small piles at the entrances of the burrows, and in the runways which extend from one burrow to another often at a considerable distance.

RABBITS

Rabbits and hares are distributed over practically the entire United States, but reach the height of their abundance in the West.

Jack-rabbits and snow-shoe rabbits are, technically hares, as the young are brought forth in forms under brush, and, when born, are well-furred, with eyes open, while the cotton-tail and brush rabbits usually bring forth their young in burrows and, when born, are naked and blind.

Economically, rabbits are of vast importance from the standpoint of food and the destruction of various crops. Tons of rabbits, both

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cotton-tails and jacks, are killed and disposed of locally, or shipped to other states during the winter months.

RABBITS OF COLORADO

White-tailed Jack-rabbit, *Lepus campestris campestris,*
Townsend White-tailed Jack-rabbit, *Lepus campestris townsendi,*
Snoe-shoe Rabbits, *Lepus bairdi bairdi,*
Texas Jack-rabbit,*Lepus californicus texanus,*
Black-tailed Jack-rabbit, *Lepus californicus melanotis,*
Brush Cotton-tail, *Sylvilagus, floridanus similis,*
Black Hills Cotton-tail, *Sylvilagus nuttalli grangeri,*
Mountain Cotton-tail, *Sylvilagus nuttalli pinetis,*
Colorado Cotton-tail, *Sylvilagus auduboni warreni,*
Plains Cotton-tail, *Sylvilagus auduboni bayleyi,*

Rabbits are injurious to fruit trees, feeding on the bark and girdling the trees, thereby retarding the flow of sap. Damage to trees is usually done when the ground is covered with snow and other food is not easily obtainable.

As a rule young trees suffer the greatest damage, but we have seen the trunks and lower branches of eight or nine-year-old trees girdled.

Rabbits also feed upon forage crops, grains and garden truck. They feed on hay in the stack, dig the roots of alfalfa, and cut it off at the crown. They destroy grain in the fields and in the shock. Corn is one of their favorite foods. They feed on the tender shoots when they first appear above ground, upon the ears when in the milk, and also on the shocks in the field.

METHODS OF CONTROL

We have been very successful in combating rabbits in the orchards by using poisoned apples. Insert strychnine with a knife blade in the apples and place at base of trees. The amount of strychnine to use is what can be picked up on the end of a small knife blade.

The trunks of the trees may be protected with the following repellant:

Unslaked lime	20 pounds
Flowers of sulphur	15 pounds
Water	50 gallons

Add a little salt to increase the adhesive property of the mixture. The lime, sulphur and about one-third of the water are boiled together for at least one hour, then the full quantity of water is added. Apply to trunks of the trees with a brush. After the damage is done, the injured trees may be treated, if the injury is not too severe, by applying grafting wax to the wounds, and a cover of whitewash to prevent sun scald. If trees are completely girdled, bridge-grafting may be resorted to.

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In the fields, around grain shocks or hay stacks, rabbits may be poisoned with our formula No. 46. One man reports killing 200 rabbits with one quart of this grain; another reports 104 killed with one quart in June.

Another formula that has been used with good success is as follows:

Salt	3 quarts
Strychnine (powdered)	1 ounce

Dampen and place small quantity on boards or in baking powder can lids. Place in field where rabbits are feeding.

The following formula was used successfully in Kit Carson County in 1919, according to report by County Agent H. O. Strange:

Cane seed (clean)	6 quarts
Strychnine (powdered)	½ ounce
Baking soda	½ ounce
Laundry Starch	½ tablespoonful
Salt	½ teacup
Water	¾ pint

Dissolve starch in one-fourth pint of water, then add one-half pint of boiling water to make a thin, clear paste. Mix together, dry, the strychnine and soda, and stir slowly into the hot starch paste. Then stir in the salt. Pour this solution over the cane seed and thoroughly mix.

Great care must be taken to keep livestock away from the poisoned area, and especially where the salt and strychnine mixture is used.

It is a well-known fact that when rabbits become over abundant and their range becomes overstocked, diseases reduce their numbers, sometimes almost to the danger point of extermination. Experiments have been made to spread these diseases artificially, but without success.

HOUSE MOUSE

(*Mus musculus*)

House mice have been introduced into the New from the Old World, and are now found in all the settled portions of the country. In Colorado, they are found all over the state, and are frequently caught in traps set for field mice far from settlements. I found them not uncommon at Corona, Boulder County, altitude 11,660 feet.

The following method for poisoning has been used successfully:

Wheat	5 quarts
Strychnine (Alkaloid powdered)	¼ ounce
Saccharine	¼ teaspoonful
Baking soda	¼ ounce
Petrolatum oil	⅛ pint
Water	½ pint

Dissolve strychnine in one-fourth pint cold water, then add one-fourth pint of warm water, stir in soda, saccharine, and oil, and put over fire, and heat almost to the boiling point, stirring constantly, remove

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from fire, stir in flour to make a creamy paste, pour the poisoned solution over the grain and thoroughly mix. When mixed, the grain is ready to use, and should be placed in small piles where it will be accessible to the mice.

HOUSE RAT

Rattus norvegicus

The House, or Norway rat, on account of its destructiveness to crops and property, and as a carrier of infectious disease germs which are transmitted to man with fatal results, is one of our oldest known rodent pests.

The House rat is not a native of the United States, but an immigrant from the old world, being brought in ships in the early part of the 18th century.

While rats have been a familiar pest along the Atlantic Coast and middle western and southern states for a number of years, their invasion of Colorado is of comparatively recent origin. It is true that rats have been known in Denver and Pueblo for a number of years, but it has been only in the past few years that they have invaded the smaller towns and villages, and at the present time are found over all the plains regions of the Eastern Slope. At the present time, we have no positive record of their occurrence on the Western Slope.

One of the most discouraging features of the control of rats is their adaption to any and all environmental conditions. Not only do they adapt themselves to different conditions, but they eat anything that may be classed as food.

That house rats at the present time present a serious problem to the inhabitants of the State, cannot be denied. We regret that from our own experience and the experience of other workers, we are not in a position to offer satisfactory control measures. They are very suspicious of both poisoned bait and traps. A number of commercial rat poisons are on the market, and the Departments of Agriculture of this and foreign countries recommend a number of formulas, all of which have some merit, but none are as effective as formulas used for control of other rodent pests.

We are giving three formulas as recommended by the U. S. Department of Agriculture, and the Department of Agriculture of South Africa. One formula is for Barium Carbonate, one for Strychnine and one for Arsenic poisoning.

The barium carbonate and strychnine formulas are recommended by the U. S. Department of Agriculture, the arsenic by the Department of Agriculture of South Africa.

"Barium Carbonate Formula: Barium carbonate for rats may be fed in a dough composed of 4 parts of meal or flour to one part of the mineral.

"A more convenient bait is ordinary oatmeal (rolled oats) with about one-eighth of its bulk of barium carbonate mixed with water enough to make

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a stiff dough. This may be exposed in bulk, in a pan, or put out, about a teaspoonful at a place, in rats' runs."

"Strychnine (alkaloid) Formula: Mix thoroughly one ounce of powdered strychnine (alkaloid), one ounce of common baking soda (bicarbonate), and one-eighth ounce of powdered saccharin. Put the mixture in a tin pepper box and sift gradually over 30 pounds of crushed oats in a metal tub, mixing the grain constantly so the poison will be evenly distributed. Put the poisoned grain about rat burrows or runs, but not in piles of more than a teaspoonful.

"Arsenic Receipt:

Finely powdered white arsenic	1 pound
Cheese	1 pound
Glycerine	1½ ounce
Water	3 pints
Corn meal	2½ pounds
Aniseed	½ ounce

Black aniline to color slaty gray.

"Melt cheese with glycerine and one-third of the water, then add corn meal and balance of water, and continue to heat until corn meal is thoroughly cooked. Stir in arsenic, aniline and aniseed. Lay in pieces the size of a hazel nut in rat runs and other places inaccessible to human beings and other animals."

Last spring, Mr. Joseph Keyes, of the U. S. Biological Survey, put on a rat-control demonstration at the city dump, Fort Collins. This dump had become badly infested with rats. For a period of two weeks before the demonstration, all garbage was kept off the dump. Various poisons and combinations of poisons were used. Probably the most successful poison used was ground meat (hamburger) and barium carbonate, used one part to four (four ounces of barium carbonate to sixteen ounces of meat). About a tablespoonful of the poisoned bait was placed on pieces of board or tin, and distributed around the dump.

Barium carbonate is a cheap, but slowly acting poison.

Traps, if used persistently, will greatly reduce the number of rats, but the bait should be changed from time to time to secure the best results. The traps should be handled with gloves and dipped occasionally in boiling water. Any type of guillotine trap may be used with better results than steel traps.

There has recently been placed on the market in Denver a rat trap called the "spring bottom trap." In our opinion, this is one of the best rat traps on the market, however, it may or may not be used successfully. Success depends largely on the operator and place of operation. The directions should be followed carefully.

Construct buildings as near rat proof as possible, use closed garbage cans and grain bins, and keep all food out of reach of the rats. These measures will do more to reduce rat population than anything else.

Bear in mind that most formulas will kill a few rats, but none of them will kill all the rats.

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A number of so-called "rat viruses" are widely advertised throughout the country. The manufacturers claim that the virus is disease-producing. While we have not personally tried out the different brands, others have, and our opinion is that they have little or no merit. A certain brand of rat virus is now being extensively advertised in the State. The West Virginia Experiment Station carried on some experiments with this virus and their report, in part, is as follows:

"Three young Norway rats were caught and kept confined in a large wire rat trap. Beginning with the date given and for a period of forty days thereafter, the———— was fed to the rats at intervals of a few days until ten seventy-five cent bottles had been consumed. The rats ate the cracked grain with which the virus was mixed very readily, and other food was denied them each time the ———— was given, until every particle was eaten. At the end of forty days the rats were still apparently in a healthy condition and were removed from the trap and killed with a club."

POCKET GOPHERS

Fig 3—Pocket Gopher (*Geomys lutescens*). Original in Circular No. 23, Office of State Entomologist, M. A. Palmer, Delineator.

The following species and subspecies of pocket gophers occur in Colorado:

Plains Pocket Gopher, *Geomys lutescens,*
Chestnut-faced Pocket Gopher, *Cratogeomys castanops,*
Jicarilla Pocket Gopher, *Thomomys perpallidus apache,*
Yellow Pocket Gopher, *Thomomys perpallidus aurns,*
Fulvous Pocket Gopher, *Thomomys fulvus fulvus,*
Espanola Pocket Gopher, *Thomomys fulvus pervagus,*
Coues Pocket Gopher, *Thomomys talpoides clusius,*
San Luis Pocket Gopher, *Thomomys talpoides agrestis,*
Green River Pocket Gopher, *Thomomys ocius,*
Colorado Pocket Gopher, *Thomomys fossor.*

The plains pocket gopher, *G. lutescens,* is confined to the plains region of the State south to the Arkansas Valley; the chestnut-faced gopher, from the Arkansas Valley south.

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Pocket gophers of the genus *Thomomys,* with one exception, *T. clusius,* are confined to the mountain regions and some of the species are found above an elevation of 11,000 feet.

Pocket gophers are among nature's masterpieces, from the standpoint of special adaption to environmental conditions which surround their subterranean homes. The body covering is soft and silky, to which the soil does not adhere; hind legs small and weak; forelegs large with powerful muscles; claws long and sharp, built for digging; eyes and ears small; incisor teeth long and sharp and used as picks to loosen the soil; lips grown together back of these teeth with a small opening which may be closed with the thick tongue, thus excluding the dirt from the mouth proper, leaving the incisor teeth free for digging; jaws heavy and operated by massive muscles.

This combination of sharp teeth, powerful jaws and forelegs, produces a perfect, animated, digging machine, which must be seen in action to be appreciated.

Pocket gophers spend practically their entire life cycles beneath the surface of the ground, where their runways zigzag this way, then that, in search of food, which consists of parsnips, carrots, beets, potatoes, melons, bulbs of flowering plants, roots of fruit and shade trees, alfalfa and grass roots.

That pocket gophers wander on the surface of the ground at times is beyond question, as some raptorial birds feed on them to some extent, and their capture would be impossible if such was not the case. New workings are often found in a locality so far removed from other gopher workings, that it would be impossible for them to travel the distance under ground without throwing out the tell-tale mounds of dirt that would accumulate in the runway. No doubt this wandering is done largely at night and they have often been seen and caught.

The main runways of pocket gophers are always open, and the animal uses them as a means of traveling back and forth. In excavating these runways, the gophers throw the dirt backward, and when a sufficient amount has accumulated, the gophers push the soil to the surface with their forefeet and nose through a lateral leading up from the runway. The soil is deposited on the surface in mounds, which vary greatly in size. When the gophers are through using the laterals they close them tightly from the runway to the surface.

METHODS FOR CONTROL

The Bureau of Biological Survey, U. S. Department of Agriculture, recommends the following:

"For ridding alfalfa fields, orchards and long stretches of ditch embankments, a very successful method is to poison them by placing baits of sweet potato or of parsnips in their underground runways. The bait should be cut about an inch long and a half inch square, and washed and drained. From a pepper box, slowly sift ⅛ ounce of powdered strychnine (alkaloid) and 1-10 of this quantity of saccharine (ground together in a mortar) over about four quarts of the dampened bait, stirring to distribute the poison evenly.

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"The runways, which are usually 4 to 8 inches beneath the surface, can be located by means of a probe made of any strong handle, an inch in diameter and 36 inches long. One end should be bluntly pointed. Into the other should be fitted a piece of ⅜ inch iron rod, protruding about 12 inches and bluntly pointed. A foot rest aids in probing in hard soils. By forcing down this iron rod near gopher workings, or a foot or two back of fresh mounds, the open tunnel can be felt as the point breaks into it. The blunt end of the instrument is now used to carefully enlarge the hole, a bait or two is dropped into the rnu, and the probe hole closed."

This poisoned bait as recommended, has been used successfully throughout the State, and the probe method of placing the bait works well with the mountain gophers or any of the forms of *Thomomys,* but the probe, as far as our experience goes, is impracticable for locating the runway of the plains gopher, *Geomys lutescens,* as the depth of the

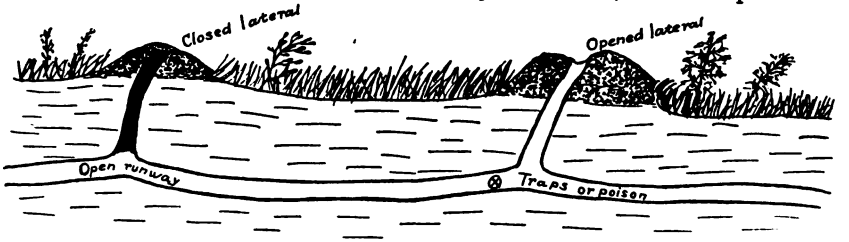

Fig. 4—Pocket Gopher Burrows. Original in Circular No. 23, Office of State Entomologist, M. A. Palmer, Delineator.

runway of this gopher varies from 12 to 24 inches below the surface.

We use and recommend the following method of locating the runway of the plains gopher:

After locating a fresh mound of dirt thrown up by a gopher, notice on the surface of the mound a slight depression where the dirt was brought up through the lateral from the main runway. This depression is seldom in the center of the mound, but to one side, as the dirt is thrown out in front of the gopher. Just back of this depression should be the main runway.

For locating this runway we use a 15-inch iron spoon with a prod attached, working from the depression down through the mound until the runway is located. Clean all loose dirt out with the hand, and place the poisoned bait as far back in the runway as possible. Close the opening at the surface with a piece of sod or newspaper, and cover over with dirt. (See figures 4 to 9.)

TRAPPING POCKET GOPHERS

After ten years of experience trapping pocket gophers with a number of different makes of traps, taking all points into consideration, we are satisfied that the Macabee gopher trap is the most satisfactory one we have used. If your local dealers do not handle this make of traps ,they may be secured from the manufacturer, Z. A. Macabee, 110 Market St., Los Gatos, California. The price of the standard size trap has been $2.00 per dozen, delivered.

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Fig. 5—Locating a pocket gopher lateral. Fig. 6—Cleaning out the lateral to the runway. Fig. 7—Cleaning out the runway with the hand.

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For our Colorado gophers, we do not agree with the manufacturers in the directions they recommend for setting these traps. They make the following statement:

"The hole through which the trap is introduced into the lateral or the main runway should be left open. The Macabee trap is sprung when the gopher pushes against the trigger-pan in its effort to stop the opening."

From our experience, this is just the opposite of what should be done as the gopher in bringing dirt to stop the opening, springs the trap with dirt and fails to get caught.

After the gophers are through using the external opening or lateral for a passage for removing the dirt accumulated from digging, they pack it solid down to the main runway, which is always kept open. See Figure 4.

If two traps are set in this open main runway, facing in both directions of approach, and the lateral closed with a piece of newspaper and covered over with dirt, the gopher will, in travelling back and forth, spring the trap with its head or body.

Our recommendations for setting the traps are as follows: Select a fresh mound, and by working down the lateral through the mound with an iron or hard wood prod, locate the main runway. Clean the opening to the runway with a long-handled spoon or with the hand. Should the runway branch two ways, set two traps facing up the runway in opposite directions. After setting the traps, secure them with a stake, chain or cord, and close the opening as directed above.

With these methods, our catch ranges from 75 to 90 percent, while with the other method, the effectiveness of the traps has been reduced fully 50 percent.

In April, 1923, Mrs. C. L. Corkins, at that time a deputy from this office, carried on some experimental work in Pueblo County to determine the cost per acre of exterminating pocket gophers with traps and poison on a give number of acres. The traps used were Macabees, and the species of gopher was *Thomomys f. pervagus*. His report follows:

"TRAPPING AND POISONING GOPHERS APRIL, 1923

Poisoning

"Amount of poisoned bait prepared	2 gallons of carrots
Time necessary to prepare bait	1 hr. 15 min.
Number of holes treated	130
Number of acres treated	20
Number of hours work placing bait	7
Number of baits (pieces of carrots) used	250
Cost of bait	$1.40
Time required to kill one gopher	8.7 minutes
Approximate kill	50 per cent

Trapping

Average length of time for catching one gopher,	10.9 minutes
Percentage of catches based on holes set	75 plus
Number of traps used	72
Cost of traps	$12.00
At 35c per hour, cost of labor per gopher killed	6.4c
Number of acres poinsoned and cleaned by traps	15
Cost per acre of poisoning and trapping	84c"

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Fig. 8—Placing the poisoned bait. Fig. 9—Closing the opening with a newspaper. Fig. 10—Covering the opening with dirt.

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Fig. 11—A pile of 130 pocket gophers trapped in five days by Mr. C. L. Corkins with 72 traps in Pueblo County, Colorado, May, 1923; also two traps and a spoon used in digging holes for traps. Photo by C. L. Corkins.

ENGLISH SPARROW

(Passer domesticus)

English sparrows were first introduced into the United States from England on the Atlantic coast, in the early fifties, and have gradually extended their range westward. The writer first observed them in the fall of 1894, when a flock of twelve or fifteen were seen near Fort Collins. They were also reported from different sections of the State about the same time.

The English sparrow is an example of the danger of introducing foreign birds into this country. Our native birds have been placed here by nature to fit each environmental condition, and if the money and energy were spent on their protection that has been spent on the introduction of foreign birds, it would not be necessary for us to look to the old world for birds that may prove a curse instead of an economic blessing.

There is no doubt that English sparrows consume a large amount of noxious weed seeds and injurious insects. On the other hand they eat more grain than our native sparrows.

If total extermination were possible it would indeed be a blessing, but this we cannot hope to do, but we can, at least, keep them under control by shooting, trapping and the use of poison.

The formula as given under "House Mice," may be used successfully for these pests.

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The sparrows should be baited for a few days until they become accustomed to the feeding place. Then put out the poisoned grain. The dead birds should be picked up, from time to time, so as to avoid suspicion.

PINON JAY

(Cyanocephalus cyanocephalus)

Other names are pinon squawker, pinon bird, and cedar bird.

Any of the names may be used, but we prefer pinon jay, as this is a true jay belonging to the family Corvidae, the family which includes jays, magpies, and crows.

The food of the pinion jay consists of insects, pinon nuts, juniper berries, etc.

In their native haunts jays do no harm, but when they invade the grain fields they become serious pests. Of grain they are very fond, and corn seems to be their favorite. They begin to feed on the corn when it is in hard roasting ears; stripping off the husks, they eat the kernels and leave nothing but the cob. They invade the corn fields in large flocks.

The following formula for poisoning these birds is recommended by this office, and has been used successfully in the State:

Whole corn	16 quarts
Strychnine (Alkaloid powdered)	1 ounce
Saccharine	⅛ ounce
Baking soda	1 ounce
Water	1 pint
Flour	½ pint

Directions: Dissolve the strychnine in one-half the prescribed quantity of cold water, then add the other half in warm water; stir in the saccharine and soda; put over fire and heat almost to the boiling point, stirring constantly; remove from the fire; stir in flour making a creamy paste; pour the poisoned solution over the grain and thoroughly mix.

When the grain is mixed it is ready to use. Scatter around the edges of the fields, or where the birds are feeding.

The rodent work in the State is carried on under a cooperative agreement between the State Entomologist of the Colorado Experiment Station, the State Extension Service, and the Biological Survey, U. S. Deparment of Agriculture. However, the writer is wholly responsible for the text in this Circular, and the formulas are ours unless otherwise stated.

Other available circulars along the same line from this office are:

No. 14—The Striped Ground Squirrels of Colorado.

No. 18—Meadow Mice

No. 31—Food habits of the Ring-Necked Pheasant in Colorado.

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Circular 40 August, 1923

Mormon Cricket Control

By C. L. CORKINS

Office of State Entomologist
COLORADO AGRICULTURAL COLLEGE
Fort Collins, Colorado

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E. ROBERTS ----------Clerk

The Mormon-Cricket-control campaign reported in this circular was made possible by the personal efforts of Governor Wm. E. Sweet, and the officers of the Denver Civic and Commercial Association in raising the necessary funds for its support, by a subscription of $2000 by the Southwestern Division of the American Red Cross, by financial contributions from Moffat and Rio Blanco Counties, and, perhaps most important of all, by the contributions of a very large amount of time and labor by the people in the infested district.

If any of the above-mentioned co-operating parties had failed us, the work could not have been successfully carried through.

C. P. GILLETTE, State Entomologist.

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MORMON CRICKET CONTROL*

By C. L. CORKINS, Deputy State Entomologist.

The first record of this insect as an agricultural pest was in 1847 during the early settlement of Utah by the Mormons. Because these 'hoppers were black and somewhat of the general appearance of a cricket, the common name of "Mormon Cricket" was then adopted and has become of universal usage. Technically speaking, however, they are wingless, long-horned locusts or grasshoppers.

The invasion of this pest into the crops of the Mormons the first year was indeed disastrous. Nothing was saved. Undauntedly, they planted seed the second year, but again the crickets came in larger hordes than ever. With the seemingly inevitable loss of another crop, the people faced starvation. At this juncture, sea gulls came from off Salt Lake by the thousands and, before all the crops were devoured, completely controlled the crickets.

This Mormon or Western Cricket has undoubtedly been a native of the Western Slope of our State for many hundreds of years. Some of our oldest cattlemen tell of encountering enormous bands of them during the earliest days of settlement by the white man. The Ute Indians have long been familiar with this insect and have made use of it as food. Since the earliest settlement of northwestern Colorado, it has intermittently been more or less of a menace. Very often, considerably more alarm has been felt on the part of the residents than the actual loss of crops justified. In late years, with the advent of the homesteader and dry farming upon a large scale, the loss of crops has been more serious and the problem one of considerable importance.

Outbreaks of the Mormon Cricket in the State, which have been recorded by Professor S. Arthur Johnson,** occurred during the years 1879, 1882, 1895, 1900, 1902 and 1904. From 1904 until 1921, natural conditions have kept the crickets in check so no appreciable damage has been reported. In 1922 a scattered infestation extended from Price Creek in Moffat County to the Utah line, bounded on the north by the Bear River and on the south by the county line. The largest and thickest bands occurred on Blue Mountain and in the Danforth Hills. Damage to crops was partial in some instances, total in others. The loss amounted to about $15,000 to $20,000.

LIFE HISTORY AND DESCRIPTIONS

The Eggs.—The eggs are about one-quarter of an inch in

*Anabrus simplex Hald. Order, Orthoptera, Family, Locustidae.
**Bulletin 101, The Agricultural Experiment Station of the Colorado Agricultural College.

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Their natural habitat—rugged, brushy hills, intersected by fertile, cultivated valleys, characterize the region of infestation.

length, and slightly crescent shaped. When first deposited they are of a dark chocolate-brown color, but upon exposure to the air, they take on a more grayish hue. The outer surface or chorion is very thick, thus giving excellent protection. This would suggest that considerable moisture would be necessary for hatching.

The eggs are laid by mature females, largely during the late summer, from the middle of July up until September. Infrequent oviposition by a few females may be noticed the first of July. The eggs are laid singly and are not placed in pods for protection as is the case with the common, short-horned grasshoppers. So far as I have observed, each female lays but one egg before extracting her ovipositor and moving on to a new location. The depth of oviposition very often depends upon the nature of the soil. If possible, the ovipositor of the female is inserted its full length of about one inch. When unable to force it deeper into the ground, eggs may be found right at the surface or even protruding.

For egg-laying a somewhat firm, yet not very hard soil, usually rather free from roots, is selected. The barren slopes of coulees and hills, open spots among the sage brush, roads and fields that have recently been stirred are favorite places. Altho

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loose sand may be used for oviposition, hard, rocky soil, as is sometimes supposed, is not often selected.

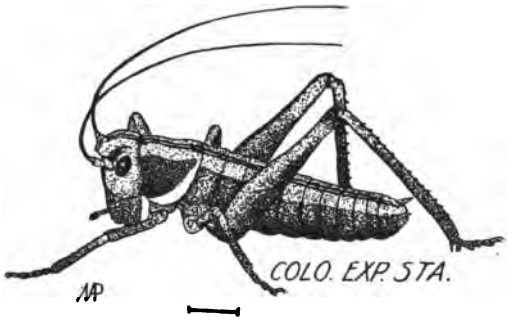
Normally, egg-laying is common in the early forenoon and the late afternoon. On cool, cloudy days, crickets may be found ovipositing freely at most any time. A female may deposit several hundred eggs during the course of the season.

The Nymphs.—During the latter half of April and the first half of May, the eggs hatch into "baby crickets" known as nymphs. Except that these are only about a quarter of an inch in length, they very much resemble the adult insect. They are coal-black in general color, with a broad, light-cream stripe down the back and a similar, narrower, oblique stripe on the side of the prothorax.

Upon feeding, growth must naturally take place. Since the body covering is hard and will not stretch, they must necessarily shed their skin to accommodate growth. To accomplish this, the cricket will crawl up onto some sort of vegetation and hang by its legs with the head down. By muscular contortions, the old body covering is split down the back, the head and thorax pulled out of the jacket, and the abdomen and legs freed by muscular activity aided by the force of gravity. In the course of a few minutes, the insect drops to the ground, immaculate, in a new and larger coat of pinkish brown. At first it is so soft that it will scarcely support the muscles. It soon becomes hardened and darkened in color by the air and sun. The old skin, a parchment like effigy, is left dangling from the object upon which the insect rested. This process is termed molting.

Molting occurs every week or ten days, depending upon weather conditions, until the adult stage is reached, after which no further growth or molting takes place. In these various stages, the nymphs may vary considerably in color, being black, brownish or even green with cream markings.

The Adult.—Late in June and during early July, the adult crickets appear. After the last molt, they are at first brown in



Young of the Mormon Cricket, (Anabrus simplex), only a few hours from the egg. Enlarged six times. M. A. Palmer, Delineator. Original in Colo. Exp. Sta. Bul. 101.

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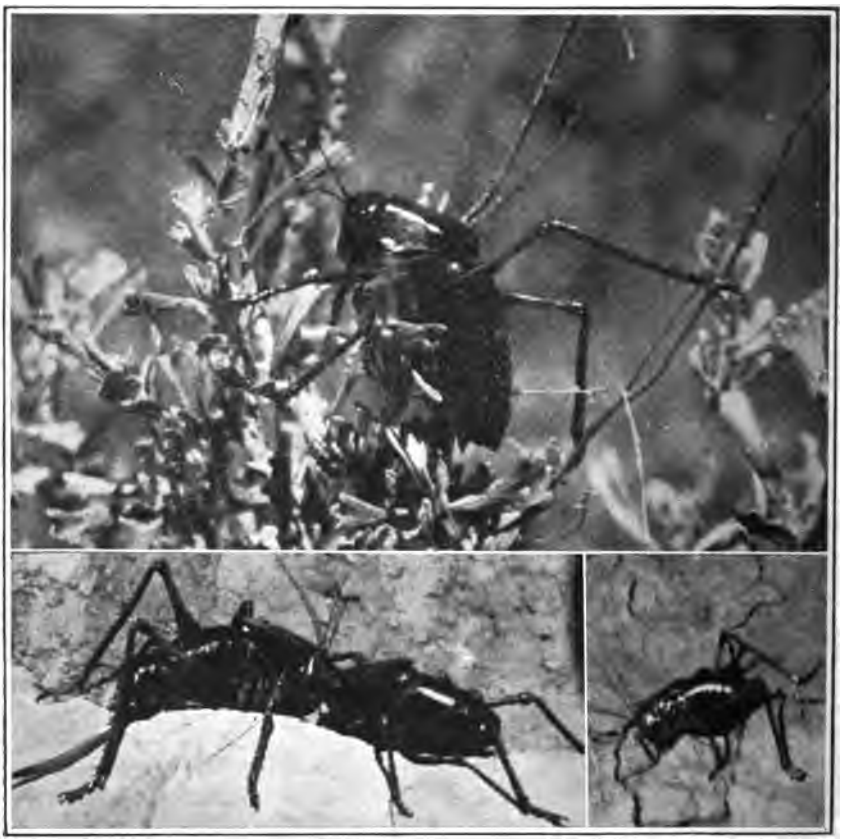
color but soon become coal-black. The males have wing pads sufficiently developed so they may chirp or stridulate, and the females have a sword-shaped ovipositor on the end of the abdomen about an inch long. The body, excluding antennae and ovipositor, varies from one to one and a quarter inches in length.

The insects are now sexually mature and will soon copulate and begin laying eggs. Thus the life cycle is completed, making one generation each year.

HABITS

Food.—The Mormon Cricket is practically omnivorous, displaying a widely diversified appetite. It is both herbivorous and carnivorous, tho by far the greater proportion of its normal food



Upper: Male of the Mormon Cricket roosting on sage brush. Lower left: Male and female courting. Lower right: female ovipositing. Original in State Entomologist Circular No. 36.

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is vegetable. It seems to be especially fond of moisture and shows preference for succulent foods.

We know of no agricultural plant that is immune from attack. Garden crops are especial favorites, particularly onions. All cereal and cultivated forage crops are devoured with great relish.

Of the native plant foods, lupine and other wild legumes and tender weeds are preferred. Sage brush, buck brush, scrub oak, willows and service berries may be attacked. Little damage is done to blue-stem, the most important native grass. Ordinarily the foliage of this plant is injured but little, tho the seed may be entirely eaten. However, with a heavy infestation, more serious defoliation of blue-stem may occur. On the whole, the greatest loss of native pasture is the destruction of the lupine.

Of its many foods, both animal and vegetable, a fellow cricket who has become weakened, injured or has died, seems to be first choice. Whether or not the victim is dead, seems to make little difference. Ofttimes the abdomen will be partially eaten away tho the sufferer was still making protestations by the chirping of its wings. No sex discrimination is displayed by the cannibals, females eating either females or males and males doing likewise.

Doubtless most any flesh food is relished by these 'hoppers. They have been known to eat dead mice, snakes, birds and fish.

Cannibals. An injured fellow cricket is the choicest morsel of all.

Fresh horse manure is attacked as tho it were an uncommon delicacy. I have counted as many as 157 crickets upon the fresh droppings from one horse. They are also attracted by mammalian urine. Oak single-trees saturated with the excrement from horses and pitch fork handles salted by the perspiration of the workmen, are attacked and deeply pitted.

Nature of the Injury.—Cereal crops, before they become headed, are eaten to the ground. When the kernels begin to form, these are preferred and the heads may be completely

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stripped. One effort to make hay out of headed rye before the crickets got it, resulted in complete failure. After the rye was cut and in the windrow, the heads were attacked and the kernels eaten. As the hay was pitched onto the load, swarms of crickets rained down out of each forkful. With the kernels gone, the hay was of little value.

Clustering.—At night, the crickets show a decided gregarious instinct, clustering together under sage brush, buck brush, scrub oak, or other vegetation for protection, until they may be several inches deep. A bushel or two may be found under one clump of sage brush. They do this, probably, to keep warm.

In the daytime, should a cloud obscure the sun, the crickets quickly scurry too cover and again cluster. Then, if it snows or rains, they are piled together under the cover of the brush for mutual protection.

Since these insects are largely dependent upon the heat of the sun to warm the body, the crickets do not break cluster and cannot become active until the sun's rays have beaten down upon them for sometime in the morning. Without the aid of the sun's warmth, they are usually sluggish and quite inactive.

Time of Feeding.—Following a night of fasting, when the crickets break cluster in the morning, the heaviest feeding period of the day begins. In the early spring, when the crickets are small, this may be seven or eight a. m. During the midsummer, after the crickets have reached the adult stage, the cluster is broken as early as five a. m. This period will last from one to three hours, after which marching is begun and little attention given to eating.

A second lighter and more erractic feeding period begins about four p. m. and continues until sunset.

Migration.—The Mormon Crickets display an instinct of migration from the time they are hatched thruout their entire existence. While small, they may move only a few yards or rods each day, but when full grown they may negotiate a distance of a mile and a half. The direction of migration seems to make but little difference, separate bands going in exactly opposite directions the same day.

Migration begins immediately after the morning feeding, and continues until noon, when the excessive heat may drive them into the brush for two or three hours, after which time marching is resumed. Just where they are going, or for what purpose they are moving, is a question. They seem guided only by an inherent instinct of dispersion.

Temperament.—These insects differ from our common destructive grasshoppers in having a decidedly more nervous and

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Wheat ahead. Advance guard of a cricket army entering a field of wheat which is just up.

excitable disposition. When one individual becomes alarmed and jumps aimlessly about, a circular wave of excitement spreads out for several yards, reminding one of the circular waves formed by casting a rock into a lake. This quality of temperament is very noticeable when the crickets are feeding upon the baits put out to poison them. Even tho the food may be pleasant, they persist in being on the move, so that after eating a bit, they may pass on. Seldom do they settle down and consume a full meal. It is very probable that this has a direct bearing upon control measures noted later.

Nature of an Infestation.—These 'hoppers occur in bands, scattered over the mountains and valleys. Some of these may cover less than an acre and others an area as large as six miles long by a half mile wide. When the crickets are small, there may be as many as one to two thousand to the square yard. Adults on the march usually stay close enough together so that there are from a hundred to two hundred to the square yard. Naturally, only a small percentage of the total occupied area is infested, but the condition becomes very serious when 3 to 5 per cent of the territory is covered at one time.

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CONTROL MEASURES

Poison Bran Mash.—The most efficient and economical method of control yet devised, is a modification of that so universally used in the destruction of our common grasshoppers. Following considerable experimentation and an experience of two seasons actual field control, we recommend two formulas, known as Colorado Grasshopper Baits Numbers 16 and 17. The former is the one we have used with good results in a sixty ton campaign this season. The latter is the most promising formula tried out in my experimental work, and was tested on a large scale under field conditions with excellent results. It is highly recommended for future work.

Colorado Grasshopper Bait No. 16

Bran (free of shorts)	100 pounds
Salt (crushed rock)	5 pounds
Amyl acetate (Tech. No. 1)	3 oz.
Sodium Arsenite (50% As_2O_3)	3 pints
Water	10 to 11 gallons

Colorado Grasshopper Bait No. 17

Bran (free of shorts)	100 pounds
Salt (crushed rock)	5 pounds
Molasses (any cheap grade)	1 quart
Sodium Arsenite (50% As_2O_3)	3 pints
Water	10 to 11 gallons

Bait No. 16 is mixed the afternoon before using the following morning and covered with wet sacks. This allows the moisture to soak thru the flakes of bran, moistening them so they are more palatable to the younger crickets and allowing the poison to gain a more even spread. The physical quality is also improved by standing over night, the flakes breaking apart more readily upon broadcasting.

Bait No. 17 is fermented before using. To accomplish this, the mixed bait is placed in a barrel or on a tight floor, covered with wet sacks and put where it is warm. Sufficient fermentation will take place in from 3 to 5 days, depending upon the temperature. One should be very careful not to leave it so long that the mash will have a musty, moldy odor. It should have the pleasant, sweet odor of fermenting malt.

The Bran.—Bran, free of shorts, should always be used. The gluten in shorts will cause the mash to ball up and stick together upon broadcasting. Most millers of the State have shown a fine spirit of co-operation by running bran free of shorts for this purpose, tho they seldom make it as a commercial practice.

The Amyl Acetate.—In using the amyl acetate, or banana oil, the following cautions should be borne in mind:

1. Procure only pure banana oil which is recommended by College authorities. Grades lower than Technical No. 1, which contain adulterants, will not give satisfactory results.

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2. Banana oil used in excess of the amount given in the formula may act as a repellant. Be sure to accurately measure the exact quantity.

Sodium Arsenite.—Sodium arsenite is used as the poisoning agent in place of white arsenic, because it is quickly and entirely soluble in cold water. This gives the following advantages:

1. Mixing is positively "fool-proof," because every flake of bran which is moistened, is also poisoned.
2. Every flake of bran is evenly and entirely poisoned, so every portion of a flake that a cricket may eat, will poison. With white arsenic, the poison is simply stuck on to the flake of bran in particles here and there. This is an important advantage when the crickets are restless and eating sparingly.
3. It is a more virulent poison than white arsenic, as it is immediately assimilated upon entering the digestive tract. Therefore less total arsenic can be used, making this poison cheaper than white arsenic.
4. Being liquid and put up in small containers, it is more convenient to use in the field and there is less danger of poisoning the mixing crew.

Two pints of sodium arsenite per hundred pounds of bran will usually give as good killing results in five days time as the three pints recommended. However, it seems justifiable to use the extra pint because:

1. It will stop the feeding of crickets within a few hours.
2. Crickets will begin to die within twenty-four hours, so a migration can be quickly halted and the poisoned swarms kept track of.
3. When feeding is erratic and the crickets are eating but little, it insures a kill even if only a very small amount of bran is taken.

Arsenical poisoning is slow. Crickets will die from twenty-four hours to seven days after the poison is eaten.

When the crickets are about three-fourths of an inch in length, and are migrating freely, use two quarts of sodium arsenite to 100 pounds of bran. This will more effectively stop the migration.

The amount of water needed will vary with the physical quality of the bran. The coarser the bran, the less the water requirement. The mash should not be sloppy nor even wet enough to stick together upon broadcasting. It will usually require eleven gallons of water for either of these formulas.

Mixing the Mash.—Mixing may be accomplished either by hand or by a power machine. Where the population is sparse and the farms widely separated, so less than fifty men use one mixing station, hand mixing is by far the more practical. A building with a tight board or cement floor makes an ideal mix-

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Preparing for battle. The mixing crew of the Price Creek camp.

ing station. In lieu of this, mixing may be done out doors on large tarpaulins or in wooden or metal vats.

Two hundred pounds of bran can be conveniently mixed at one time. The water, salt, banana oil (or molasses) and sodium arsenite are placed in a tank or some other adequate receptacle and vigorously stirred. When the salt is dissolved, this "soup" is poured over the bran and mixed in by means of beet forks, shovels or rakes. Five or six mixings from one pile to another will usually be sufficient. When left to stand, keep covered with wet sacks.

Application.—After mixing, one hundred pounds of mash, figured on the dry basis, will cover from ten to fifteen acres. Enough should be broadcast so the crickets cannot clean it up before all have had a feed. Usually the tendency is to spread too much rather than too little. A thin sprinkling, scattered as evenly as possible over practically all of the ground, is desired.

Where the ground is smooth, the mash may be broadcasted by hand from the rear of wagons, buckboards or even automobiles. However, the country where the crickets are very often found is so rough and brushy that it is impossible to get vehicles thru. Ofttimes it is necessary to take supplies in on pack horses. The mash can then be applied from horseback, or, if too

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brushy for this, the distributor must walk, carrying his supplies in a knapsack or bucket.

The distributor should be able to cover a swath from three to four rods wide. The mash is thrown up and out into the air as far as possible, in order that it may break up finely and give a good spread. If there should be a breeze, it will scatter best if thrown crosswise to it.

In poisoning a swarm, enough men should be used to cover the full extent of one dimension, being deployed at three to four rod intervals. Also, if at all possible, a given swarm should be covered entirely in one day. Otherwise a mixing of unpoisoned crickets with the poisoned ones, makes checking of results impossible and the crew will be unable to know where to begin work the following day.

The time of feeding is the only safe guide for the time of day for application. **Poisoning should therefore be done in the morning only, from the time the crickets break cluster until about three hours later.** Mash put out before the crickets break cluster will be dried up by the sun and become more or less worthless before feeding takes place. The period of usefulness of the mash is chiefly from thirty minutes to an hour after it is

The firing line. The mash was distributed from wagons or from horseback, when possible; in the brush (to right) was deployed a line of distributors on foot.

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applied. Hence the necessity of application only at the exact time the insects are feeding.

On the whole, application should be made only during sunshiny weather. There may be exceptions to this. In fact when passing clouds are intermittently obscuring the sun for a few minutes only, the crickets are discouraged from marching and will eat readily. At times, when the sky is overcast with thin clouds, the temperature may be sufficient to keep the crickets stirring about enough so they will take the bait.

The time the crickets break cluster in the morning and the length of the period of feeding may therefore vary from day to day with weather conditions. Observations of the way the crickets are taking the bait must be made each day and several times each day. The poisoning crew should be guided by these daily observations, more than by any general rules.

When to Start Poisoning Campaign.—The biggest lesson learned from experience with this year's campaign was the necessity of starting poisoning while the crickets are small, and completing operations before they are more than one-half to two-thirds grown. This means that all the details of organization must be worked out and the supplies on hand within three weeks after the first crickets hatch. Poisoning should then, normally, begin from May 10 to 20, depending upon seasonal variations. It should be completed by the middle of June at the latest.

While the crickets are small, they remain clustered together in small bands, out in open country. As they increase in size, the number of crickets per square yard decreases, with a consequent increase of the total area covered. Then too, the larger crickets will enter the service brush and scrub oak thickets, where poisoning must be accomplished by hand. Work done early will save at least one-third of the labor and poison, as well as give better results.

Number of Applications.—The number of applications will depend upon the efficiency of each spreading, which may vary somewhat with a number of factors. Under actual field conditions, these baits have given from 60 to 95 per cent kill. One application is seldom sufficient. Two or even three are the more usual number necessary. These are made at from five- to seven-day intervals to allow sufficient time for the previous application to make its total kill as well as for the survivors to bunch together into a smaller band.

Cost of Treatment.—The cost of treatment will fluctuate from year to year with the cost of supplies. However, during this season and under the conditions which prevailed in the Moffat County campaign, the cost has been as great as can usually be expected. A combination of an unreasonably high price on bran and a 73-mile auto truck transportation problem made the

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Encouragement. The dead were found covering the ground 48 to 72 hours after poisoning.

cost of supplies laid down at headquarters very excessive. Even at that, the cost of materials for each acre actually treated has been from forty to fifty cents for one application. It should usually be less than this.

Danger of Stock Poisoning.—Carelessness should be the only reason for the loss of any stock from the use of poison-bran mash. If it is properly broadcasted in the field, and no chunks are thrown out, application may be made in pastures or on the range where livestock are grazing without the least danger. Hundreds and thousands of tons of mash have been so distributed without the loss of animals. However, all possible care should be exercised to see that distribution is properly made. This is not a job for boys or irresponsible men.

Especial care should be exercised to see that the mixing stations, and places where mixed mash is kept, are stock tight. More stock has been lost from carelessness at the mixing stations than from any other cause.

In the event that an animal should become poisoned, two different antidotes are given. The one first listed is the better.

Aqua ammonia	4 oz.
Sulphate of iron solution	6 oz.
Magnesia	2 tablespoons full

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Keep each ingredient separate until ready to use. Place ammonia in a pint of water, slowly add the sulphate of iron. When combined, add the magnesia. Give as one dose. Repeat every 20 minutes for the first three hours. Then give at intervals of three hours for two or three days.

Magnesia	1 oz.
Tincture of Iron	4 oz.

Dissolve magnesia in a pint of water, and then add tincture of iron. Give as one dose. Repeat dosage every 20 minutes for the first three hours. Then give at three-hour intervals for two or three days.

As a precautionary measure, these antidotes may be kept on hand at the mixing stations. Have the druggist put them up in parcels of one dose each.

Because of the large amount of the poisoning agent used in this formula, the mash should not be distributed where poultry is running. However, there is little or no danger of fowls becoming harmed by eating poisoned crickets.

Other Means of Control.—Spraying foliage with arsenical poisons, except with a mixture of molasses and sodium arsenite, will not be satisfactory. Spraying the swarms with a contact insecticide such as kerosene emulsion will give results. However, any spraying method is prohibitive from the standpoint of the equipment necessary and impractical because of the roughness of the country and the scarcity of water.

Burning of sage brush at night, by entirely surrounding a swarm with fire, will destroy millions, but from the standpoint of the labor involved, cannot be used in a large outbreak. Some residents believe that they can drive the bands of crickets, but others with more experience have abandoned this method as hopeless.

NATURAL CONTROL

Birds.—From year to year, birds do much to keep the crickets in check. But with the advent of a large outbreak our sparse bird population is wholly at a loss to control the situation, even tho they may flock in from many miles in unprecedented numbers. The birds which we have noted as being of especial importance are Brewer's blackbird, meadow larks, ravens, magpies, robins, pinon jays, sage hens, ground sparrows, horned larks and hawks of all kinds. Especial encouragement should be given these birds, as altogether too often, as is the case with the hawks, some of the farmers' best friends are ruthlessly destroyed in ignorance.

Insect Parasites.—As yet, no important insect parasites of the Mormon Cricket have been observed. The habit of cannibalism may account in part for this. Were a parasite to infest a cricket, the cricket would become weakened and consequently be devoured by its fellows, parasite included.

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Weather.—Cold, snowy weather seemingly does no harm to young crickets. April 30, 1923, four inches of snow fell in the Price Creek district and the mercury fell to 10 degrees above zero. A large percentage of the crickets were hatched before this time, but were unharmed.

Probably a considerable amount of moisture is required to hatch the eggs. It is my opinion that an open winter with little moisture in the spring might prove disastrous to the crickets.

Tho we do know that outbreaks of crickets have come and gone, we are unable to say what natural factor has been responsible for their suppression. Yet it is encouraging to realize that our ignorance will not prevent Dame Nature's work, and that our present invasion will doubtless sooner or later be crushed.

ORGANIZATION FOR CONTROL

The control of the Mormon Cricket is necessarily a community problem. With the migration of large bands from the mountains, travelling for many miles during one season, it is an altogether hopeless task for the individual farmer to attempt to cope with the situation. The time to attack the crickets is during the latter half of May and the first half of June, before the insects have reached the adult stage. At this time, they are found most abundantly on waste lands, and are the potential pest of anyone within a radius of 10 to 20 miles. Thus it becomes necessary to organize on a community basis and enlist the co-operation of every one within, as well as those many miles without, the infested territory.

"Let's fight." Such was the battle cry at this all-day organization meeting at the Arnold ranch.

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Because the organization used in the 1923 campaign in Moffat and Rio Blanco counties has proved practical and workable, it is here briefly explained. It was perfected thru the active cooperation of the office of the State Entomologist and many of the leading citizens of the infested territory. Unfortunately, no county agricultural agent was available, for the assistance of such would have been valuable.

The executive committee in charge of all operations at the Price Creek Headquarters was made up of officers and members of the Price Creek Grange. It consisted of:

Edward Weller, Master of the Grange.
W. H. Arnold, Sec'y of the Grange and of the Campaign.
C. E. Deming, Treas. of the Grange and of the Campaign.
R. L. Shenton, Quartermaster and Fieldman.
John Templeton, Head Linesman.

This committee as a whole conducted the business of the organization. The master of the Grange presided over the committee. The secretary was actively in charge of operations and was responsible for all records and reports of the campaign. The treasurer paid the bills upon request of the secretary and the office of the State Entomologist. The quartermaster was re-

Anywhere, anytime. Such was the schedule of the head linesman who co-ordinated the work of the many camps.

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sponsible for getting the supplies to headquarters, after which time he acted as fieldman. In this capacity he visited the field stations, gave help in organization, instructions in operation and assisted in remedying any difficulties at the camps. The head linesman acted as liaison officer, taking information between camps and headquarters and co-ordinating all operations.

The infested territory was divided into two divisions, the "Price Creek" and the "Cross Mountain." The Price Creek Division was managed by the headquarters staff, while the Cross Mountain Division was in the charge of the Cross Mountain Grange, of which Frank Barnes, Jr., was the master. This division was responsible to Price Creek Headquarters. These two divisions which covered an area of 70 miles long and 25 miles wide, were then subdivided into 17 districts, each made according to natural boundaries. Each of these districts then elected a district foreman, who was placed in charge of all work in his territory. These were responsible to their division officers.

The organization in an individual district was composed of:

1. Mixing crew
2. Distribution crew
3. Scouting crew
4. Transportation detail

Because the period when distribution can be made is so short each day, all hands turn out in the morning for the purpose of spreading the poison. The district foreman supervised this work personally. This being completed, the crew was divided, one part sent to camp to mix supplies for the next day, and the other, under the leadership of a head scout, to scout for new bands of crickets.

District foremen kept daily records of all the work done, the results of the poisoning and reported anything of interest and value to headquarters. These daily reports were sent to headquarters thru the head linesman.

In this manner, the complete organization was under the daily supervision of the headquarters staff and co-ordinated to the best possible efficiency.

All labor, even of the officials in charge, was given free of charge and gladly.

FINANCING THE CAMPAIGN

Due to the nature of an infestation, as before described, it is impossible for the individual farmer to finance his own control campaign. A Mormon Cricket campaign must needs be supported by the county, or by popular subscription, or the combination of the two. Due to the deplorable financial condition of the counties affected, the latter means was used in the 1923 campaign.

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Let's find them. Scouting crew of the Price Creek camp.

As early in the spring as it was learned that the crickets were hatching, the Office of the State Entomologist surveyed the territory and decided upon the amount of funds necessary for adequate protection. An appeal then was made to the Hon. Wm. E. Sweet, Governor of the State, to actively take charge of raising money by popular subscription to make the campaign possible. This he so energetically did that within a short time the needed money was supplied by the business men of Denver, the Civic and Commercial Association of Denver, and the American Red Cross, co-operating. Additional financial assistance was given by Moffat and Rio Blanco counties.

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